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*APPLIED BOTANY AND ITS DEPENDENCE UPON SCIENTIFIC RESEARCH.**

UNFORTUNATELY for me, the time for this address before the Society for Plant Morphology and Physiology comes so far along in the twentieth century that there is opportunity for neither a retrospective nor a prospective view of botany, even were I competent to assume the rôle of an historian or a prophet. I had, therefore, thought of presenting a somewhat general discussion of some of the problems involved in soil bacteriology, but, fortunately for you, this has recently been done before another society by another investigator, so that there is no reason for digging over the same soil here. On the other hand, the discussion of some purely technical botanical subject connected with my particular field of work seems more properly to belong to that part of the program devoted to scientific papers. Consequently, by this process of elimination, the only question of general interest occurring to me seems to be that one which most of us have grown tired of answering and yet, because of the tendency of this age, is the one which we have to answer more often than any other, namely, Of what good is botany? Why do we teach it? and above all, Why have we as men and women allied ourselves with such a profession? Far be it from me to attempt to defend botany against all who are now engaged in its pursuit. These are matters for one's own conscience, but for those of us here, members of the Society

* Address of the president of the Society for Plant Morphology and Physiology, Philadelphia, December, 1904.

for Plant Morphology and Physiology and other societies in good and regular standing, I think, perhaps, it may be well to discuss for a short time the importance and significance of botany as a science and a profession, in order that those who are unfamiliar with the situation may realize that we have as distinct a part in the world's work as a banker, an engineer, or a bricklayer.

So hard pressed have scientific men sometimes been for an excuse for their existence, that I know of at least one instance where the reply of Cuvier to the practical jokers trying to frighten him by impersonating the devil, has been given as a legitimate reason for being acquainted with certain facts regarding the structure of animals. Perhaps you are not familiar with the story. It seems that Cuvier while a young man incurred the enmity of certain of his colleagues, who decided to give him a severe fright by dressing one of their number in the conventional garb of Satan and making a midnight call upon him. It is presumable that being aroused from a sound sleep, Cuvier was duly impressed with the figure before him and that some of the threats made were having the desired effect. But finally, in a last effort to overwhelm him, the devil threatened to eat the young scientist. This was a fatal mistake, for Cuvier, at once reassured, eyed the grotesquely-clad figure from head to toe and exclaimed, "What, horns and hoofs and carnivorous! Never!" He then rolled over and went to sleep.

Now, I can not maintain that the study of botany will enable one to detect the real devil from an impostor; neither do I consider that the botanist has any need for such knowledge. The particular use of the story, however, well illustrates, I think, how great has been the necessity at times for resorting to any means calculated to demonstrate the value of pure science to a certain class of people.

The test, of course, which nowayears is applied to any science or profession by a large part of the world is: What is it worth? How much money does it influence? What industries has it created? The money value of botany to those engaged in it, I will pass over in silence, it being impossible to say so little that a fair proportion would be maintained between the words and the compensation. But to those not teaching or studying it, those who have criticized botany and botanists for their lack of efficiency, and to the world in general, the value of our profession is so great that we may well feel proud to be among its numbers.

It may be regarded as an admission of weakness to even discuss the practical side of botany. But we who daily come in contact with the results obtained from our knowledge of plants are apt to forget that the large part of those engaged in other professions still look upon botany as it was considered fifty years ago, the whole function of which was so aptly described in the word to teachers by Mrs. Lincoln in 1845. She says: "In the first meeting of a botanical class, after some explanation as to the nature of the study they are about to commence, each member shall be presented with a flower for analysis." That this was the chief object of all subsequent meetings seems to have been taken for granted by many who have never had an opportunity of belonging to a class in botany. Perhaps it will be worth while to quote still further from this same book which served as an introduction to the subject for more than one of the sturdy pioneers whose names shall ever stand high on the roll of botanical achievement; for it is well to know how much foundation there is for certain opinions now held by the uninformed. In the introduction to

Mrs. Lincoln's 'Botany' you will find the following, 'The Study of botany seems peculiarly adapted to females,' and then, as if to justify this statement, she adds: "A peculiar interest is given to conversation by an acquaintance with any of the natural sciences, and when females shall have more generally obtained access to these delightful sources of pure enjoyment, we may hope that scandal, which oftener proceeds from a want of better subjects, than from malevolence of disposition, shall cease to be regarded as a characteristic of the sex. It is important to the cause of this science that it should become fashionable; and as one means of effecting this, the parlors of those ladies, who have advantages for intellectual improvements, should more frequently exhibit specimens of their own scientific taste. The fashionable *et cetras* of scrap books, engravings and albums do not reflect upon their possessors any great degree of credit. To paste pictures or pieces of prose or poetry into a book; or to collect in an album the wit and good sense of others are not proofs of one's own acquirements; and the possession of elegant and curious engravings, indicates a full purse rather than a well-stored mind; but *herbariums* and books of impressions of plants, drawings, etc., show the taste and knowledge of those who execute them."

We have here one result of the effect of botanical pursuits, which perhaps accounts for the well-known fact that botanists are freer from gossip and kindred vices than other scientists, and when we remember (if we may be allowed to quote once more) that this science is 'especially recommended to strengthen the understanding and improve the heart,' many things are made plain. But, seriously, the fact must be acknowledged that even at the present time there are altogether too many fair-minded people who have the idea that botany is a somewhat effeminate calling, and that while it does very well for ministers who have lost their voice, or for others who are unfortunately disabled, the taking up of the subject by an able-bodied man necessitates an explanation which is not always complimentary.

By hard work it has been possible within recent years to emphasize the pedagogical importance of botany, and the fact that accuracy, observation, discipline, etc., are inculcated by this subject has helped to raise it to something like the place it deserves in many curricula. But even here the struggle to differentiate botany from that all-containing, but often little-meaning term *biology* has usually resulted in most of the credit going to the animals instead of the plants. For while the improvement has been most encouraging in the last few years, it must be confessed that the proportion of botany to zoology in many biological courses is as that of copper sulphate to water in a reservoir treated for the extermination of algæ. But even after botany has received all credit due her from the purely educational standpoint, there is a vast majority who are still unconvinced of its worth and who think that the time of both student and instructor would much better be spent in some line that 'fits one for being of some account.' It is admitted by authorities that there are some subjects now taught whose only real claim for being maintained in schools and colleges is their pedagogical value. Botany is fortunate in having additional causes for its importance, and for this reason, if for no other, it should not rest its entire claim for existence upon purely educational grounds.

That botany has a definite practical field aside from distinguishing deadly from edible mushrooms, or being able to tell poison ivy when you see it, is usually something entirely new to that most impractical of persons, the so-called practical man, and the assertion that years spent in looking

through the microscope or in the scientific investigation of problems concerning plants could ever add to the world's wealth or be classed as a productive pursuit, is often quite beyond his comprehension. Because botanists generally want the interest of this class of men, would like their advice occasionally, and under all circumstances need their money, it is well perhaps that now and then the utilitarian side of the study of plants be emphasized, even though it may shock a few of those who seem to have associated themselves with the profession because they consider it so absolutely incapable of being turned to account. For it must be confessed that there still persists a small class of botanists who look upon anything practical connected with the subject in much the same way that a physician regards advertising. Just why it should be a disgrace to undertake a problem which has a definite industrial application is a little difficult to understand, but there can be no question that some investigators need no further inducement to drop a piece of work than to have it intimated that possibly it may result in some good. It is to such members of the profession that we owe, in part, at least, the comparatively low place botany takes to-day as one of the applied sciences.

It is also true that the indifference of many of the earlier botanists to those problems, the solution of which promised to be of actual service to mankind, has made it necessary for other more enterprising scientists to undertake work not strictly within their province and has resulted in the credit accruing to their particular field rather than to botany, where it belonged. It is a fact to be regretted, but which can not be denied, that systematic botany so occupied the attention of the early students of plants that it was necessary for physicians and chemists to make nearly all the investigations carried on in plant physiology and similar branches of the subject. This naturally led many to consider that there was nothing to botany except the analyzing of flowers and recording their names, and although this branch of the subject contributed its share to the establishment of applied botany, it was not sufficient of itself to bring the profession to the high position it deserves as an industrial science. Even now the old order of things is so strong upon some of us that there still exists a kind of feeling that any investigation carried on with plants, other than their systematic determination, is not pure botany and should be relegated to the chemist or physicist. While this is unfortunate, it is not of so much consequence as at one time. Such a condition, however, tends to prevent a proper estimate of the value of our science in comparison with others, and makes it possible for such statements as the following, recently made in a public address, to go unchallenged: "Practically all forms of productive activity from the cultivation of the soil for the growth of cotton to the finished tinted fabric, from the digging of the ore to the engines which distribute our commerce in its most varied ramifications, rest upon chemical phenomena." I think it is about time for the botanist to begin to assert himself, at least to demonstrate by his work and the results obtained that botany has fully as large a place in productive activity as any of the other sciences, and that much more credit is due to the student of plants than is ordinarily supposed.

Another reason why botany has not taken first rank among the applied sciences is that when investigation has shown the study of certain plants to be of vast economic value, the results have been of such importance that that particular line of work has soon assumed the proportions of an independent science, and consequently the parent has often been lost sight of in

the admiration for the child. I imagine the members of the Society of American Bacteriologists would be somewhat surprised if they were asked or expected to merge with other botanical societies and form a section in any large botanical organization. And yet this is the only logical place for them, and in the time of Cohn and DeBary there would have been no question about it had the bacteria been considered of sufficient importance to warrant a separate section. It will not be long, if indeed the time has not already arrived, when forestry will cease to give any credit to botany for the practical results being obtained by this rapidly developing profession, and other examples might be given to illustrate the general tendency to magnify the industrial branch of a science at the expense of the main body from which it originally, at least, obtained its strength.

Part of this diversification in botany is due to the fact, of course, that as a science it does not involve certain methods as in the case of chemistry or physics. It is usually a simple matter for the average person to recognize the benefits derived from either of the two last-named sciences, because they are definitely associated with test tubes and balances, reagents and dynamos, and other well-known objects.

This recognition of the method is carried to such an extent as to result, in university catalogues at least, in such hybrids as 'chemical-engineering,' 'chemical-mineralogy,' 'mathematical-geology,' 'mathematical-biology,' etc. An investigation into what is usually taught under such heads shows that it would be fully as legitimate to establish courses in botanical-architecture because of the knowledge of woods required, or zoological-engineering since the power is reckoned in horses. As well try to assign all work involving retorts and reagents to chemistry, to call everything botany or zoology which requires the use of a microscope, or claim for physics the exclusive privilege of developing all industry involving light or heat or motion, as to maintain that because a method originated in one science it can not be applied in another without uniting the two, or even losing the problem involved in the contemplation of the tools to be used in solving it. There are certain definite lines of research which appear to all fair-minded investigators as belonging to certain fields. The question to be answered is either chemical, zoological, botanical or whatever the case may be. A dozen sciences may contribute to its solution, but the fact should always stand out preeminently as to its real origin. This has not always been the case in botanical problems, and it may be a matter of some time before workers in general recognize this principle. Nevertheless, I think it extremely necessary that botanists do not fail to call attention to such cases and that in the future no opportunity be lost to obtain all proper and legitimate credit for our science and profession. The time for modestly sitting in the background and seeing our best fields for work appropriated by other sciences should have passed.

It may seem as though I were a long time coming to the second part of my subject, but the ignorance regarding the industrial importance of botany, as compared with the other applied sciences, seems to call for some explanation, and I have sought to point out, very imperfectly I will admit, a few of the reasons which have occurred to me as accounting for this peculiar situation.

To attempt to give even an outline of the many botanical achievements which have been of economic importance is manifestly impossible in the time at my disposal. Neither is it necessary to submit a catalogue of the work accomplished by those most eminent in our profession.

I do think, however, that any evidence calculated to enhance the importance of pure investigation (that most necessary source of practical results in botany) should be referred to frequently, because there is no use in attempting to conceal the fact that the average man of the world looks with contempt upon the general subject of scientific research as undertaken in botany and similar fields. That certain so-called scientific investigations carried on in the name of research are far from being in any way a contribution to science must be admitted; but so much good work is being done that it is time that we make a little more of an effort to have it receive proper recognition. Perhaps the day will come when research work will appeal to the world upon its merit. Certainly the last ten or fifteen years have seen a great advance in this line, but at present there is no question but that the best and quickest way to obtain the recognition and reward due to pure botanical research is to show how practical results are obtained by this means, which years of blind groping along applied lines have failed to produce.

If I may be allowed to take an example or two from my own experience, I will refer to the investigations leading up to the solution of the problem involving the prevention of bad odors and tastes in drinking water. This disagreeable effect, due to the growth of algæ, has been one which has baffled the efforts of engineers, chemists and bacteriologists for years. And well it might, for why should a question of this kind, involving the life history of a certain small group of cryptogamic plants, be referred to any other profession than botany for its answer?

There is not a state in the union which has not reported difficulty from these algal growths, and in some communities the odor and taste during certain months of the year have rendered the water absolutely unfit for use. In a few cases the strong odor has even necessitated the giving up of the use of the water for sprinkling the streets and lawns. One water commission in New England considered the trouble due to algæ of so much importance that they were willing to expend about four million dollars upon devices, by no means certainly effective, in order to try and prevent such difficulties. A city in the far west spent over one million dollars securing new sources of supply so that the algal-polluted reservoirs might be abandoned. In the south we have a case where the algæ led the local authorities to take steps to cause the franchise of the water company to be forfeited, on the ground that they were not furnishing a potable water. The company had spent thousands of dollars in mechanical filters and other devices, without results, and there was no alternative but to install a new supply at a cost of double the one already in use. There is no necessity for multiplying examples. Those of you who are familiar with the question of furnishing pure water in this country know how many millions of dollars have been lost owing to the presence of algæ in water, to say nothing of the great inconvenience caused by the odor and taste and for which there did not exist an adequate remedy. It is needless to say that a question of so much financial importance has been investigated exhaustively from the so-called practical side, and various recommendations made, all of little or no effect. Finally, the difficulty was relegated to the botanists, who took hold of the problem from the purely scientific standpoint and showed how certain plants were the specific cause of the trouble. It was then a comparatively simple matter, by applying the knowledge gained years ago by Naegeli and others in botanical research, to find a remedy for the difficulty. The only wonder is that it was not thought of before. Within the last six months the

method of destroying or preventing the growth of algæ in water supplies, as devised by the Department of Agriculture, has been used with marked success in over fifty water supplies throughout the country, on a scale running into the hundreds of millions of gallons, and causing a saving in money difficult to estimate. In fact, there is now on file a list of testimonials from hard-headed, practical, business men which should make systematic algology and plant physiology hold up their heads with pride. The whole matter has created a demand for trained botanists able to tell the difference between *Volvox* and *Uroglena*, which can not be supplied, and there is no doubt but that within the next few years the leading water companies will consider an algologist as important a member of their staff as the bacteriologist, and under certain conditions, of much more practical necessity than a chemist. It is difficult to prophesy what will be the future of this method which applies our knowledge of plant physiology in such a simple manner. Physicians and health officers are making use, in a number of different ways, of this piece of botanical investigation, and the employment of copper in one form or another, as an efficient means of fighting typhoid, cholera and similar diseases is undoubtedly destined to become of the utmost importance. I have referred somewhat in detail to this example because it seems to me to offer a very strong argument in favor of the ability of scientific research to furnish the solution for some problems which ordinarily might not be considered as falling under its influence. Here we have a long history of failure, due to the lack of scientific information. I am sure no one can realize how complete and absolute that failure has been until he has had an opportunity of examining the reports made by the practical men who have been attempting to solve the difficulty. It is no wonder that it was not until the investigation was transferred from the reservoir to the laboratory that the remedy was found.

Perhaps no branch of botanical research seems farther removed from the practical side of life than that usually referred to as cytology. The killing and fixing, staining and cutting of plant and animal tissue, seem to be an operation calculated to result in but small good to mankind, however much it may add to its store of information. But it is not beyond the range of possibility that these very cytological investigations of Farmer and other botanists may be destined to throw much light upon what may be termed the most important unsolved problem in medicine. Most of the diseases in the world are the result of filth, or imprudence, or some condition which could be prevented if we would. Tuberculosis, diphtheria, typhoid fever and similar contagious forms can generally be prevented and are most certainly curable, if we but use the knowledge that scientific research has given us. But cancer remains as the one dread disease, about which authorities are in dispute even as to its origin. Ask any up-to-date physician, thoroughly familiar with the results of research in laboratories at home and abroad, what is the most baffling, the most hopeless disease, the one thing he oftenest meets for which he has no remedy, and there will be no hesitation in his reply of cancer. That the cytological investigations of Farmer and others, concerning the abnormal growths occurring on ferns, may lead to the ultimate solution of the cause and cure for cancer, we can only hope; but certainly they have been able to throw a flood of new light upon the nature of malignant growths in man which can not but be of practical value.

The application of facts obtained from pure research in that most practical line of botany—plant breeding—is well known to all of you. Of the utmost theoretical importance, this branch of botanical in-

vestigation makes it possible to increase the yield of wheat and corn a definite measurable number of bushels which the farmer can appreciate at once. It is useless to enumerate the fruits, grains, fibers, etc., that have been improved by this means. It has been said that in the breeding of plants we have a practise unconsciously carried on for centuries, and that the ordinary selection of the farmer results in as great improvement as can be obtained from the application of scientific knowledge as to the strains best adapted for crossing and selecting. If this be true, why is it that all these centuries have not given rise to the results, easily obtained in one generation by the scientific way? No one would for a moment wish to dispute the great good that has resulted from the use of the knowledge gained from experience in the raising of plants for commercial purposes, but when one has witnessed the immediate benefit of the application of science to the traditional practises of the farmer and horticulturist, he can no longer deny that the combination is more practical and more efficient, and results in returns vastly in excess of those obtained when the methods are separated by prejudice or ignorance.

It is always easier to estimate the value of any piece of work when it is possible to base it upon what has been actually gained, rather than upon any loss which it prevents. Consequently, the vast saving to this country because of the investigations made upon plant diseases is usually overlooked. No line of botanical research has resulted in a greater practical benefit to the farmer and those engaged in the growing of plants for profit, and yet it is seldom that the tedious and necessary investigations carried on by the mycologist, upon which all intelligent remedial work is based, receive due credit.

If we turn to the realm of beneficial bacteriology and mycology, there are, of course, innumerable instances of the direct results obtained from botanical research, not only in those processes having to do with the growing of crops for man and beast, but also in increasing the value and importance of numerous industries. See how necessary the trained mycologist has become to the brewer! No industry is more scientific in its methods, and it required but the investigations of Hansen and Jörgensen to place the business upon a plane of absolute security, scarcely enjoyed by a manufacturer depending upon the most mechanical and routine processes. By the pure yeast cultures the brewer has everything under his control, for the mash is sterilized by boiling and the addition of the hops prevents the growth of deleterious bacteria which might be added subsequently. Thus, there is no reason why the beer made a year hence should not be precisely the same as that made to-day.

The maker of wine has not been so quick to take advantage of the information furnished by botanical research, and in many cases the results of his labors are lost, or at most, the product is often far from what it might have been had the proper plant furnishing the proper enzyme been specifically added, instead of its being left to chance. While it is true that there may be difficulties attending the sterilization of the grape must, which, of course, is laden with wild yeasts and moulds, to say nothing of the bacteria, it seems more than probable that by proper attention to the acidity of the must and by adding the pure yeast in considerable quantity so as to overcome the objectionable forms, most beneficial results may be obtained. Certainly, the only way in which the making of wine is to be placed upon the same precise and satisfactory basis as that of malt liquors, is by investigations concerning the purely scientific processes involved and not

by a continuation of the old hit-or-miss, inaccurate methods developed centuries ago before there existed any botanical research.

It is not necessary to refer here at length to the wide influence research has had upon the dairy industry. Slow as we are to abandon long-established custom, the introduction of the pure 'starter' for the production of a standard type of butter is coming more and more into use, and the certainty with which it is now possible to obtain an agreeable and pleasant aroma in butter, with no danger of spoiling the product, is what has made possible the vast creameries of the present day.

While it is probable that the part played by bacteria is not so important in the ripening of cheese as formerly supposed, the necessity for the lactic bacteria in acidifying the milk for the production of a good curd is well recognized. We also know that in some kinds of cheese moulds are essential to produce the characteristic flavor so much relished by some. In addition, the supplying of certain bacteria, known as 'langvey' in Holland, plays a most important part in preventing the deterioration of the cheese, owing probably to these organisms keeping down the growth of objectionable forms by exhausting certain necessary food products. This latest discovery is likely to open up a new field in the dairy industry, as, in a sense, it does away with the necessity of keeping out all deleterious organisms, and permits a good product under conditions which otherwise would make it impossible to manufacture cheese at all.

The debt owed by the tiller of the soil to the vast number of purely botanical investigations of so much money value to the farmer, is but seldom recognized or acknowledged. To admit oneself a scientific farmer is to at once invite a deluge of almanac and comic weekly jokes that have been accumulating against this class since Adam began to work for his living. And yet, barring conditions beyond the control of man, the only way in which the most profit can ever be obtained from a farm is by adhering rigidly to the information based on pure science, much of which has been discovered in the botanical laboratory. It is quite true that certain wild speculations, masquerading as scientific research, have resulted in unjustly causing many practical men to look upon botanical investigation as being the last thing to prove beneficial to those who grow plants for profit. But the farmer is beginning to distinguish between the real and the false, and it will not be long until it is recognized that the only man who fails to make a success out of his land is the unscientific one, who either can not or will not take advantage of the practical facts put at his command by the investigator in the laboratory, who may not know the difference between a double shovel and a disc harrow.

It is also interesting to note that our science can no longer be disregarded by the judge and the lawyer as being without their sphere, for it has been possible for the botanist to invade the field of expert testimony in a most practical fashion, and the number of cases demanding the knowledge which can only be properly furnished by a student of plants are constantly multiplying. In one instance, an increase from $9,000 to $25,000 in the damages asked, was due directly to the evidence submitted, depending entirely upon plant histology and physiology. And the basis upon which a verdict of $20,000 and costs was finally rendered was the possibility of demonstrating damage by the discussion of such strictly botanical subjects as cross-sections of rose leaves, cambium, photosynthesis, root pressure, etc. That the result would have been different had the attorney for the defendant possessed a little botanical knowledge is perhaps a question, but there

is no doubt but that his examination and cross-examination were sadly confused for the want of a few correct ideas about plants.

After all, it is not so important to dwell upon what scientific research has done in the past for practical botany and related subjects, as to emphasize what it may do in the future. Fortunately, botany is not yet at the place where she desires to stop and contemplate her achievements in a spirit of self-satisfaction or contentment. The unsolved or uncompleted problems of the industrial world waiting for help from the botanists are many, even more, perhaps, than the botanist himself realizes. No one man could enumerate them and any attempt to more than suggest the opportunities in a few lines with which I am most familiar would be presumptuous. Therefore, I hope it will be understood that my idea in mentioning the possibilities of scientific investigation in one or two specific cases is not intended as an indication of what I myself may hope to accomplish in this way, or as suggestions to others who are engaged in more important work. I merely wish to indicate to those not familiar with botanical research how we realize that much remains for us to do.

To begin with a very homely example, the investigation of the bread yeasts offers a fertile field for some botanist desiring to be of service to his fellow-man by improving one of the most necessary and important manufacturing processes carried on in domestic life. An examination of many of the yeast cakes upon the market will show that they usually are as rich in bacteria as in yeast cells, no particular care having been taken to maintain the purity of the yeast. While we have had some investigations pointing out the bad effect of certain of these bacteria upon the bread sponge, it is more than likely that other bacteria may be of great importance in converting the starch to sugar; at any rate, definite scientific knowledge is necessary before we can hope to get the best practical result. The possibility of improving the bread yeast itself is also a piece of work which I am not aware has yet been undertaken. When it is remembered that the source of most bread yeast is a beer yeast and the function of the two is not by any means the same, it would appear that some careful cultural work would be calculated to greatly improve the ease and certainty with which good bread might be made. Another possible point of improvement lies in the fact that the bread yeasts on the market are generally selected because of their rapidity of multiplication. Since it is now known that this function generally varies inversely as the gas forming power, it would seem more than likely that by no means the most efficient type of yeast was now being used for bread-making purposes.

Tanning, flax and hemp retting, and other similar industries dependent upon fermentations set up by various micro-organisms, all offer most inviting possibilities for the utilization of the results of pure botanical research. Because certain operations, worked out by experience and many failures, have been carried on for centuries with a fair measure of success, is no argument against the scientific investigation of the fundamental processes underlying the results obtained. It is more than probable that by the discovery of the precise organism involved, and the elimination of the undesirable, if not harmful, forms introduced accidentally, certain industries in this country can be revived and put upon a paying basis undreamed of by the practical man. At any rate, if improvement is to come, it must be as the result of information acquired by means of the scientist working in his laboratory, rather than through the efforts of the business man and manufacturer in the shop.

The possibility of large practical results from botanical investigations along agricultural lines seems to be particularly promising at the present time, probably because so many botanists are directing their attention in this direction. What the future has in store for the farmer of this country, because of the researches now being carried on in plant pathology, plant physiology, soil bacteriology and other branches of botany, can only be conjectured, but that much of real value will be forthcoming there can be little doubt. In no other field are the opportunities so great; in no other way are the practical returns of botanical investigation so sure.

When the farmer is made to realize that the soil upon which he is so dependent is not dead and inert, but a living, changing thing, the laboratory in which some of nature's most wonderful miracles are performed, he will be more ready to accept help and advice from a man who may not know how to plant and reap, but who understands the nature of the growing and the fruiting and the factors controlling them, as only one who has given himself to searching for botanical truths can know them. And when such knowledge applied by the farmer means all the difference between success and failure, an increase of one hundred to one thousand per cent. in his crops, the growing of new plants in new ways, the successful combating of ruinous diseases, the conservation of the real worth in the manure pile instead of allowing all its fertilizing power to be wasted into the air—these and many other practical results will at no distant day establish botanical research as one of the most necessary and beneficial aids to the most important industry in the world.

Before I conclude, it may be well, perhaps, to inquire into the nature of the research now being carried on in botany under the name of scientific investigation. Is it always scientific, or, indeed, even botanical? Does it in every case result, not necessarily in creating value where waste and worthlessness existed, but in that real addition to knowledge and the clarification of the subject which is supposed to be its function? I am sure you will agree with me that nothing so tends to prevent the advance of any science as for it to be loaded down with a vast weight of undigested facts, which are published and republished by man after man in the fond belief that they are 'contributions to knowledge.' Such a practise can not always be prevented, but it behooves botanists to realize their responsibility and to do all in their power to elevate their science and the character of the work being done under their direction. It does not necessarily follow that because a man has just taken his bachelor's degree that he is qualified to carry on the investigation of some real problem in botany, even though his instructor does give him the subject. Far be it from me to advocate in any sense of the word a commercial test for botanical investigation. There are many problems in botany which all of us want answered, but which probably will never be capable of an industrial application, and no one wants them to be. Furthermore, it is not given to us to determine the outcome of any particular line of work, and those fields which have seemed furthest removed from utility have often yielded results the most beneficial. I do wish, however, that the test always applied to scientific work which has a practical application might also be used, at times, at least, in judging all botanical investigation. There can be little doubt about the wide difference in the scrutiny given a paper prepared on some technical subject, upon which the writer is no doubt able to speak with authority, but which will at most provoke a controversy between some half dozen others in the world who are

likewise authorities, or think they are, upon the same subject; and in promulgating a theory or a method of economic value which will be tried by thousands with no regard for your feelings, if it fails to accomplish all you have claimed for it.

If this proving of our botanical work, by the rules and regulations of a practical world, accomplished nothing else, it would certainly tend to make the general character of scientific investigation a little more exact and definite than it has always been in the past. A clock striking the half hours near midnight does not always give the information you wish. It may be half-past twelve, or one, or half-past one, and in spite of the number of times it makes itself heard it is of no more value and not nearly so satisfactory as a clock not striking so often, but telling the time when it does strike. We make many claims for the high ground upon which scientific research stands, but I am inclined to think that the motive behind part, at least, of the botanical investigation of this country is no further removed from criticism than if it were undertaken for the mere dollars and cents involved in a commercial proposition. It is a fine point in ethics to determine whether the reward of a degree, a fellowship, or a teaching position for a piece of scientific research, places the work and the worker upon a higher plane than when similar investigations are undertaken for the purpose of solving a problem of definite money value which, unfortunately, for this reason alone are apt to be more accurate and more complete.

And here I think it may not be out of place to felicitate those who have been so instrumental in building up the *true* botanical research of this country (and those who have had the good fortune of being under their instruction are also to be congratulated), upon the very high place Americans have come to occupy among the botanists of the world.

Not long ago, while visiting the laboratory of a noted German botanist, I asked if he had any American students. "No," he said, "I do not expect to have any more. There is no need for you Americans to come to Germany any longer. You have the men and the laboratories. One needs only to come to Europe for the language or to look at specimens." Is it not time that the botanists of this country began to let it be known that even the Germans are recognizing our worth and our facilities, and that when a student goes abroad it is no longer because no one in this country is capable of teaching him, but for the language, the experience, the travel? Indeed, if it did not sound too vain-glorious, I would have no hesitation in saying that, in certain lines, at least, we have so far exceeded the foreign teachers and laboratories that it can not be long until the tide turns in the other direction and the most anti-American botanist will be forced to come to us for information.

The day is easily within the memory of some men now teaching chemistry, when this science had no more standing as an economic subject than botany has now. I believe, if botanists but realize the necessity of calling the attention of the world to the practical results already accomplished, and will maintain the standard of true scientific research at its highest point, that botany will very soon take the foremost place among the applied sciences. Further, I am of the opinion that the uniting of *all* those professionally engaged in the study of plants into *one* efficient, active organization could not but hasten this day, and that it would not be long until chairs of applied or industrial botany would be as necessary in a thoroughly equipped university as they are now considered for certain other sciences. We have scarcely more

than begun the scientific investigation of a field which offers the widest opportunities for results. Not only does it seem probable that practically new lines of business are to be created by botany, but the improvement in old methods which have been maintained for centuries simply because 'our fathers' did that way, has already demonstrated to the most conservative that the scientific botanist, true to type, is a man of immense practical value to the farmer, the manufacturer, the engineer and the world at large.

May we none of us, by our work or our words, retard the rapid advance now being made, along both pure and practical scientific lines, of our chosen science—botany.

GEORGE T. MOORE.

BUREAU OF PLANT INDUSTRY.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. SECTION B, PHYSICS.

THE annual meeting of Section B, Physics, of the American Association for the Advancement of Science, in affiliation with the American Physical Society, was held in Philadelphia on December 28, 29 and 30, 1904. The attendance was representative in an unusual degree of the physicists of the entire country, including not only those from many important institutions of the east, but also from the south, the west, and from California. The average attendance was nearly one hundred.

The retiring vice-president, Edwin H. Hall, introduced the presiding officer, Professor W. F. Magie, of Princeton University, the vice-president of Section B. The other officers of the section who were in attendance were Dayton C. Miller, secretary; Henry Crew, councillor; A. W. Goodspeed, member of the general committee; and the following members of the sectional committee, W. F. Magie, E. H. Hall, D. C. Miller, E. L. Nichols, F. E. Nipher, G. F. Hull, A. G. Webster, D. B. Brace.

For the next meeting, to be held in New Orleans, beginning December 29, 1905, the presiding vice-president is Professor Henry Crew, of Northwestern University. The other officers for the New Orleans meeting, so far as now determined, are:

Retiring Vice-President—W. F. Magie.

Members of the Sectional Committee—Henry Crew, W. F. Magie, D. C. Miller, E. L. Nichols, F. E. Nipher, G. F. Hull and A. G. Webster.

Secretary—Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

On Thursday the retiring vice-president, Professor E. H. Hall, of Harvard University, gave an address on 'A Tentative Theory of Thermoelectric Action.' This important paper, which is printed in full otherwhere in this journal, was listened to by an unusually large audience.

Twenty-two papers were read before Section B, all of which were of such importance that it was generally expressed that this meeting was one of the most valuable that Section B has ever enjoyed. The subjects may be classified as follows: on light, nine papers; on electricity, five; on meteorology, two; and on general subjects, six papers. Papers on related subjects were grouped together more than had been usual before, and ample time was allowed for discussion. This arrangement added to the value, as well as to the enjoyment, of the sessions.

Beginning on Friday, December 30, the sessions were in charge of the American Physical Society; a large number of valuable papers were read, an account of which is given in the report of the Physical Society.

The abstracts of the papers read before Section B are given below.

Note on the Mirror-Telescope-Scale Method: GEORGE F. STRADLING, Manual Training School, Philadelphia.

Let a ray of light of fixed direction fall upon a mirror turning about a vertical axis. The reflected ray is received upon a plane. If the incident ray passes through the vertical axis, and this axis lies in the plane of the mirror, and the plane on which the reflected ray falls is parallel to the mirror-plane, the curve traced by the spot of light as the mirror turns is a hyperbola. Discussion of another case.

Some Convenient Laboratory Apparatus: Horace C. Richards, University of Pennsylvania.

I. *An Apparatus for Quickly Washing and Filling Vessels with Small Openings.*—It consists of a small glass cylinder mounted on a suitable stand and provided with three outlets, one leading to the vessel which is to be filled, one to that containing the liquid, and the third to an aspirator through a trap. The liquid is first drawn up into the cylinder and then, by intermittent working of the aspirator, is driven into the vessel. A similar process empties the vessel and carries the liquid over into the trap. For mercury, etc., the form is slightly modified so as to prevent loss of the liquid.

II. *A Simple Automatic Mercury Washer.*—Mercury is raised by an aspirator into a vessel placed above a vertical tube filled with dilute nitric acid. When the vessel is filled, the aspirator is automatically shut off and at the same time air is admitted by a pair of valves operated by a float. The mercury then filters through a small valve in the bottom of the vessel and falls in small drops through the column of acid. It is then returned to the reservoir from which it was drawn and so is passed around through the acid as often as is desired, the aspirator being set in action again when the upper vessel is nearly empty.

The Double Suspension Pendulum for Determining the Absolute Value of the Acceleration of Gravity: R. S. Woodward, Carnegie Institution.

This paper describes an apparatus specially designed to avoid the difficulties presented by knife-edge pendulums and to secure a degree of precision in absolute measures of the acceleration gravity comparable with the precision already attained in relative measures.

Heat Insulation of Observatory Domes, Laboratories and Other Buildings. David Todd, Amherst College.

To prevent excessive heat accumulation in the new observatory domes at Amherst waste granulated cork is put in between the interior galvanized iron sheathing and the exterior wood boarding on which the copper roof is fastened. One and one half to two inches of cork is sufficient to keep interior iron always cool to the touch, no matter how hot the copper gets when the sun is shining normally upon it. Mineral wool would be nearer fire-proof and equally good insulation, but adds more weight. Numerical tests will be submitted.

The Relation Between Air Pressure and Velocity. Francis E. Nipher, Washington University. To be published in the *Transactions* of the Academy of Science of St. Louis.

The paper describes a method of determining the constant in the equation $P = kv^2$ when the air blows into the open end of a tube collector. The tube was bolted to a small pulley on a shaft which could be run at various speeds. The open end was 36 inches from the center of the pulley, and the plane of the opening could be set at any angle with the circular path which it describes. When at right angles to the path the air within the tube is found to be in equilibrium during rotation. The

pressure required to balance the outward radial tendency is equal to the pressure due to the wind at the open end of the tube. When this condition is imposed in the equation the value of k is obtained in terms of temperature, barometric pressure and velocity. The value is practically independent of v for velocities less than 100 miles per hour.

The Temperature and Drift of the Air at Great Heights above the American Continent, Obtained by Means of Registration Balloons. (Preliminary Report.) A. LAWRENCE ROTCH, Director of Blue Hill Meteorological Observatory.

Although the meteorological conditions of the lower two or three miles of air have been investigated by means of kites at Blue Hill Observatory during the past ten years, no observations have been made at greater heights in this country. Through cooperation with the management of the St. Louis Exposition, the author obtained such observations by means of ballons-sondes; fourteen of these balloons carrying self-recording instruments were despatched from St. Louis and all were recovered with ten records of barometric pressure and air temperature. From the barometric records the maximum height attained was found to be about 51,000 feet, where the temperature was 68° F. below zero on September 23. At a height of about 45,500 feet (the maximum of the second series of experiments) the temperature was —72° F. on December 2, the lowest temperature, —76°, occurring at a height of about 33,000 feet on November 26. The direction and velocity of the upper air currents were indicated approximately by the places and times at which the balloons fell. The velocity twice exceeded 100 miles an hour and all the balloons (excepting one which did not rise out of the surface current) drifted towards the east, in general diverging from the areas of low barometric pressure at the ground.

An account of these experiments will be published in full in the *Annals of the Harvard College Observatory*, Vol. LVIII., Part II.

Optical Refraction in the Lower Atmospheric Strata, as Affected by the Meteorological Conditions. (Preliminary Report.) A. LAWRENCE ROTCH, Director of Blue Hill Meteorological Observatory.

The variation in refraction has generally been attributed to the differences in the temperature of superposed strata of air, but there have been few investigations upon the effect of the daily changes in meteorological conditions. Accordingly, during two years, observations were made three times a day with a precise level, on the summit of Blue Hill, of the apparent angular depression of a lighthouse in Boston harbor, fourteen miles distant and 550 feet below the hill, the temperatures here and over the water being known. Since the temperature of the air over the ocean is more uniform than that over the land, there is a large annual period in their difference, but no relation between these vertical gradients and the observed refraction is evident, nor do the monthly extremes appear to be connected with the corresponding gradients of temperature. This indicates that there are other controlling influences and these are now being sought. The investigation will be published in Vol. LVIII., Part II., of the *Annals of Harvard College Observatory.*

Experimental Study of the Use of Weston Instruments for Ballistic Magnetic Testing. ALBERT F. GANZ, Stevens Institute of Technology.

At various times it has been either claimed or disputed that a damped galvanometer in which the damping force is

proportional to the velocity of the moving system may be used for ballistic magnetic testing. In the *Physical Review*, of March, 1903, there is an article by O. M. Stewart in which it is shown mathematically that such a damped galvanometer conforms to the ordinary law of the undamped ballistic galvanometer. It is also stated in this article that an ordinary Weston ammeter without its shunt or a Weston voltmeter without its series resistance may be used for determining permeability and hysteresis curves by the ballistic method.

The experiments to be described in this paper were undertaken last spring by two senior students, Mr. E. E. Greve and Mr. A. R. Barkus, under the direction of the writer, for the purpose of comparing the permeability and hysteresis curves obtained by means of ordinary Weston instruments, with the curves obtained by means of a slow-period undamped ballistic galvanometer. It was found that the curves for a laminated iron ring obtained with an ordinary Weston instrument fell about three per cent. below the curve obtained with the ballistic galvanometer. It was also found that the permeability curve for a solid iron ring (cross-section 1 sq. in. mean diam. 7 in.) obtained with an ordinary Weston instrument fell over ten per cent. below the curve obtained with the ballistic galvanometer. The cause of this falling below is undoubtedly that the time of the first swing of the ordinary Weston instrument is too short to take account of all the change in the magnetic flux which occurs. The Weston Instrument Co. then constructed a special instrument having a greater moment of inertia and more magnetic damping than their ordinary instruments, and having, therefore, also a much longer time for its first swing. This new instrument was found to give a permeability curve for the laminated ring which agreed exactly with the curve obtained with the ballistic galvanometer. For the solid ring the permeability curve was still, however, several per cent. below the curve obtained with the ballistic galvanometer. In order to make a direct reading magnetic flux meter out of this instrument ten yards of flexible cord were taken to be used for a secondary coil, and a resistance was added to the instrument, and this was adjusted so that the instrument would indicate the flux in kilomaxwells changed per turn using this secondary. This instrument was, therefore, called a 'Weston Maxwell meter.' This Maxwell meter has been considerably used in the laboratory of Stevens Institute for obtaining magnetization curves, measuring leakage coefficients, etc., and has been found extremely useful. The Weston Co. are now constructing a second special instrument having a still slower period, which is expected to give accurate results as well for solid iron samples as for laminated ones, and this will be a direct reading, portable and permanent Maxwell meter having a uniform scale, which will be generally useful for all kinds of magnetic testing and which can be used directly without previous calibration. Owing to the slow period of these special instruments the extent of their first throws can be very accurately noted.

Measurement of the Thompson Thermo-electric Effect in Iron. Edwin H. Hall, Harvard University.

Description and Demonstration of the Poulsen Telegraphone. Z. B. Babbitt, New York; Introduced by Arthur W. Goodspeed.

The principles involved in the Poulsen telegraphone and the practical construction of the apparatus were explained. The reproduction of human speech was then demonstrated.

Circular Dichroism in Natural Rotary Solutions. D. B. BRACE and W. P. MCDOWELL, University of Nebraska.

Electric Double Refraction in Liquids Under Low Electric Stresses, and also at the Boiling Point. D. B. BRACE, G. W. ELMEN and L. B. MORSE, University of Nebraska.

The Electromagnetic Theory and the Velocity of Light. HENRY T. EDDY, University of Minnesota. (To be published in the *Physical Review.*)

Mr. Mills has recently published a paper* in which he has given the results of measurements made by him of the increase in the velocity of circularly polarized light in bisulphide of carbon along the lines of force in a magnetic field. Employing circularly polarized light, he was successful in obtaining a difference of one or more wave-lengths between two rays circularly polarized in opposite senses, one ray having its velocity increased while the other was decreased, and this was obtained with apparatus with which no difference whatever was observable in case of plain polarized rays.

The apparatus mentioned is a form of interferometer devised by Professor Morley and paid for by a grant made by the American Association for the Advancement of Science for the purpose of investigating certain points to which the present writer had taken exception in the theory of the Faraday effect as developed by Professor Rowland,† who had attempted to account for the twisting of the plane of polarization of plane polarized light while being propagated along the lines of force in a magnetically active medium by the action of the Hall effect in the medium. As just stated, the present writer found himself unable to agree with that part of Professor Rowland's most valuable theoretical treatment of the Hall effect which related to rotary polarization. After a full presentation of the theoretical questions involved at the Toronto meeting of the American Association for the Advancement of Science, in 1889, the apparatus was constructed, and after many delays a final report was presented to the American Association for the Advancement of Science, at the Boston meeting, August, 1898. The report was duly published* and contains, first, the present writer's theoretical developments and computations as to the possible increase or decrease in velocity to be looked for in case of magnetic twisting of the plane of polarization, and second, a full description by Professor Morley of his apparatus and a detailed account of the experimental work by Professors Morley and Miller, who worked in collaboration. No experimental change in the velocity of plane polarized light could be detected with this apparatus, and the numerical computations just mentioned showed in fact the possible change in the velocity to be too minute to be detected by the apparatus as used. Although such is the fact with plane polarized light, the experiments of Mr. Mills show that such is not the fact with circularly polarized light. Moreover, it will be shown theoretically that in case of circularly polarized light the amount of change in velocity due to the magnetic field is expressible as a lower power of small quantities, than in case of plane polarized light, and consequently the magnitude of the change in the former case is large compared with the latter, and in fact varies as the square of the latter; and while the latter may be quite beyond the range of observation, the former may be well within it, as the experiments of Mr. Mills have proven.

In view of this it is the aim of this paper

* *Phys. Rev.*, Vol. XVIII., p. 65, Feb., 1904.

† *Am. Jour. Math.*, Vol. 3, p. 109, 1880.

* *Phys. Rev.*, Vol. VII., p. 282, December, 1898.

in the first place to rediscuss the questions at issue and point out more in detail than heretofore how, according to elementary theory, the velocities of plane and circularly polarized rays in any optically or magnetically active medium must be necessarily related to each other, and how, according to elementary theory, it is impossible that Professor Rowland's equations can represent a twisted plane polarized ray.

In the second place, it will be shown how these velocities in the magnetically active field are related to the velocity in zero field according to the several proposed hypotheses. Were it possible to make this comparison experimentally, we should have a test as to the validity of the proposed hypotheses, but such test is as yet beyond reach by reason of the smallness of their differences.

An attempt is made, in the third place, to show that a moderate degree of absorption would exert a negligible influence in modifying the results already developed for perfectly transparent media.

The conclusions arrived at in this paper may be briefly stated as follows:

1. The increase or decrease in the velocity of circularly polarized light observed by Mr. Mills, and previously by Professor Brace, are perfectly in accord with and a necessary consequence of the elementary trigonometrical equations expressing the propagation of twisted plane polarized light, and the phenomenon is independent of any hypothesis, electromagnetic or otherwise, as to the manner in which the twisting is produced.

2. The equations given by Professor Rowland to express the propagation of twisted plane polarized light are not suitable for that purpose, for they in fact express the propagation of a uniformly and continuously rotated plane polarized ray, such as is at present unknown to experimental physics.

3. The velocity of a twisted plane polarized ray is so related to the velocities of the right and left circularly polarized rays of which it is composed that its reciprocal is the arithmetical means of the reciprocals of its components; and the velocity of Professor Rowland's rotating plane ray is the arithmetical mean of the velocities of its right and left circularly polarized components.

4. The differential equation based on two different electromagnetic hypotheses as to the action of the medium in producing rotation or twisting of plane polarized light in a magnetic field involves an equation expressing the relation of the velocity of this kind of light at zero field to its velocity in the given field. On the hypothesis of orbital motions of charged ions the differential equations show that the field would cause a decrease in the velocity of plane polarized light during the twisting; while on the hypothesis of charged ions having a motion of translation across the field, the differential equations show that the field would cause an increase in the velocity by an amount one-third as great as the decrease just mentioned. This increase or decrease is of the second order of small quantities, and is so minute as to be at present beyond the range of observation, varying as it does as the square of the observed change produced by the field in the velocity of circularly polarized rays.

5. MacCulloch's differential equations involve practically the same decrease of velocity by the medium as those based on orbital motions of charged ions.

6. A moderate amount of absorption in the medium would not practically modify the conclusions true for perfectly transparent media on either hypothesis.

On the Theory of Experiments to Detect Aberration of the Second Degree. EDWARD W. MORLEY, Western Reserve University, and DAYTON C. MILLER, Case School of Applied Science. (To be published in the *Proceedings* of the American Academy of Science, and in the *Philosophical Magazine.*)

In this paper there is a reconsideration of the simple theory of aberration of the second degree as given by Michelson and Morley in 1887, and of the general theory as given by Hicks. The effects due to aberration of the first, second and higher degrees have been computed, and the results are shown in curves. The conclusion is that the original theory was correct and sufficient, and that the modifications proposed by Hicks are effective in aberration of the third or fourth degree only, or are (in two instances) due to errors in his theory.

Report of an Experiment to Detect Change of Dimension of Matter Produced by its Drift through the Ether. EDWARD W. MORLEY and DAYTON C. MILLER. (To be published in the *Proceedings* of the American Academy of Science, and in the *Philosophical Magazine.*)

The paper describes a large interferometer designed for the measurement of ether drift, and for the determination of any differential change in the dimension of matter, resulting from such a drift. The support of the optical parts is a steel truss-pattern cross, which is circumscribed by a square with diagonals fourteen feet long. By repeated reflections the optical path of the light is lengthened to two hundred and eleven feet. The whole interferometer is floated on mercury to render observations possible in all azimuths. The distances apart of the mirrors are determined by interchangeable rods, which may be of any suitable material. Experiments have been made using pine distance pieces, which give results in accordance with those of the original experiment made by Michelson and Morley in 1887 in which the distances were determined by sandstone.

The theory given in the preceding paper indicates a displacement of the interference fringes due to ether drift amounting to 1.53 wave-lengths, as the apparatus is rotated. The observations from 260 rotations show that the displacement is less than 0.015 wave-length. As the latter quantity is as small as the errors of observation, the conclusion is that there is no drift of the ether at the place where the interferometer is mounted.

Recent Experiments and Theories on the Ether Drift. D. B. BRACE, University of Nebraska.

The Elimination of Gas Action in Experiments on Light Pressure. G. F. HULL, Dartmouth College. (To be published in the *Philosophical Magazine* and in the *Physical Review.*)

When light is thrown on one vane of a torsion system suspended in a partial vacuum, the 'Crookes effect' or gas action is eliminated, leaving only light pressure effective, in the following ways: (1) By making the vane accurately vertical; (2) by *enclosing* the absorbing or reflecting surface; (3) by making the vane a cylindrical surface having its axis coincident with the suspending fiber; (4) by using inclined surfaces and polarized light.

Experiments are described and data given showing that the gas action is eliminated through large ranges of air pressure varying from about half an atmosphere up to a few millimeters of mercury.

A simple lecture room experiment is described for demonstrating that light pressure on a reflecting surface is greater than that on an absorbing surface in the ratio

of $1 + r_1 : 1 + r_2$, where r_1 and r_2 are the reflection coefficients of the two surfaces.

The Distribution of Energy in the Visible Spectrum. Edward L. Nichols, Cornell University. (To be published in the *Physical Review.*)

This paper gives definite numerical and graphical data for the variation of intensity with wave-length in the visible spectrum of various sources of light such as the Hefner lamp, the ordinary gas flame, the petroleum flame, the acetylene flame, the Nernst filament, the lime light, the magnesium light and the carbon arc light; also in the spectrum of incandescent bodies such as carbon, platinum and zinc oxide at known temperatures.

Hitherto our knowledge of these spectra has been relative, each being compared with some other taken as a reference standard. It is now possible, however, to reduce all spectrophotometric comparisons to absolute measure.

A Note on Interference with the Bi-Prism. Wm. McClellan, University of Pennsylvania.

The condition that diffraction and interference lines obtained by means of the biprism shall be seen separately, depends on the relative positions of the screen prism and slit, and the angle of the prism. The writer has taken several photographs to illustrate the various fields which may be obtained from the same prism.

The Evolution of Hydrogen from the Cathode in Gases and its Association with Cathode Rays. Clarence A. Skinner, University of Nebraska.

Exhibit of Liquid Air Machine in Operation. Arthur W. Goodspeed, University of Pennsylvania.

Dayton C. Miller,
Secretary of Section B.

The Convention of the Association of American Agricultural Colleges and Experiment Stations.

The eighteenth annual convention of this association was held in the Chamberlain Hotel, at Des Moines, Iowa, November 1–3. It was the first meeting under the new constitution, which reduces the number of sections from five to two; and the advantage of the new plan was very marked in enabling delegates to follow the discussions more closely, and in concentrating the deliberations upon questions of administration and methods of work. The two sections under the present constitution are (1) on college work and administration, and (2) experiment station work.

The general sessions were presided over by Dr. W. O. Thompson, of the University of Ohio, who delivered the customary presidential address. This dealt with 'Some Problems in the Colleges of Agriculture and Mechanic Arts,' and gave special attention to the agricultural phase of their work. Among the problems noted were the conditions in the agricultural communities, the much-discussed tendency away from the farm, and the frequent lack of opportunity on the part of the farmer's boy for individual initiative. It was urged that farm life must not be the refuge of necessity, that not all farmers' sons are suited to be farmers any more than all lawyers' sons are suited to that profession, and that marked changes in farming have taken place in recent years which call for special aptitude and training quite as much as any other work in life. It was pointed out that intelligent operation of the farm is now necessary for any margin of profit, and the fallacy that unintelligent men can make successful farmers or satisfactory farm laborers was denounced. 'We need to know that intelligence on the farm will produce results just as surely as elsewhere,'

and this leads to the requirement for agricultural education.

It was pointed out that the agricultural colleges and the agricultural departments of these institutions have been working under the disadvantage of too little money, and that there has been a lack of appreciation that agricultural education must necessarily be a very expensive form of education, calling for extensive equipment which must be maintained at considerable outlay, and other items not commonly met with in laboratory work. A plea was made for the introduction of agriculture into the rural schools, and for an extension department of the college to stimulate interest in agricultural education in the rural communities. The agricultural colleges should furnish the inspiration and initiative for these movements, and there is need of conducting a propaganda in their interest, since agriculture differs from other industries in that it will not take care of itself. The speaker held that 'the problem of agricultural education will not be solved until the agricultural colleges have been brought into close and vital relations to the agricultural populations.'

The report of the executive committee, submitted by Dr. H. C. White, chairman, described the efforts of the committee in behalf of the bills for establishing mining schools at the land-grant colleges, and for the further endowment of the experiment stations, now pending in congress; and the conferences of the committee with the secretary of agriculture and other officials of his department relative to cooperation between the department and the experiment stations. The report led to the discussion of the relations of the experiment stations and their work to the department of agriculture.

In the course of the discussion upon this subject, a resolution was introduced by Dr. W. H. Jordan, of New York, recognizing the mutually advantageous relations which have existed between the department and the experiment stations of the several states, but recording the belief of the association that the continuation and development of these relations and the maintenance and progress of efficient research in agricultural science 'demand that the autonomy and paramount position of the stations as institutions of research and experimentation be inviolably maintained within their respective states, in accordance with the terms and spirit of the Hatch Act.' The resolution instructed the executive committee to request a hearing before the proper committees of congress, for the purpose of presenting the work and claims of the experiment stations, in order that congress may be properly informed as to the work of these institutions and its value to agricultural practise; and, furthermore, to continue conferences with the secretary of agriculture relative to cooperation between his department and the stations. This resolution was adopted by the association.

The committee on the collective exhibit of the agricultural colleges and experiment stations at St. Louis, through its chairman, Dr. W. H. Jordan, presented a progress report, briefly enumerating some of the features relating to the exhibit and noting the awards granted to it.

There were the usual reports of the bibliographer, by Dr. A. C. True, and of the committee on indexing agricultural literature, both of which enumerated the bibliographies and indexes to agricultural science which had appeared during the year; and the committee on methods of teaching agriculture presented a report on 'The Teaching of Agriculture in the Rural Schools,' with a syllabus of an elementary course in agriculture.

The report of the committee on graduate study reaffirmed the plan of conducting a graduate summer school of agriculture un-

der the auspices of the association, and recommended that the school be held in future every two years, beginning, if possible, with the coming summer. The committee was empowered to arrange for the holding of such schools, and each agricultural college was requested to make an annual contribution of $25 to aid in their maintenance.

The committee on uniform fertilizer and feeding stuff laws submitted a brief report, through its chairman, Dr. H. J. Wheeler, which dealt in part with the question of nomenclature in reporting the results of analysis; this matter was subsequently referred to a special committee, to cooperate with a similar committee of the Association of Official Agricultural Chemists.

The committee on rural engineering reported, through Dr. W. E. Stone, the progress which has been made during the year in developing courses in agricultural engineering and farm mechanics at the land-grant colleges, and enumerated some of the benefits of instruction and investigation carried on by these departments. The need of a central agency in the Department of Agriculture was emphasized, to aid these new departments of the colleges, to carry on original research, and to establish laboratories for practical tests of implements, etc.

The committee on animal and plant breeding, through Professor W. M. Hays, reviewed the activity in research along these lines, and described the formation of the American Breeders' Association.

Resolutions paying an eloquent tribute to the late Major Henry E. Alvord, a former president and member of the executive committee of the association, were presented by President James K. Patterson, of Kentucky. These recorded the high esteem and affection in which Major Alvord was held by the association, and testified to his eminent services to agriculture in the various public and private capacities in which he served.

'The Social Phase of Agricultural Education' was discussed in a paper by President Kenyon L. Butterfield, of Rhode Island. He laid down the broad proposition that the agricultural college should serve as a social agency in helping to solve all phases of the rural problem, and pointed out that this was not merely a matter of technic, but a problem of economic, political and social significance. The present courses of study at the agricultural colleges were shown to deal almost exclusively with the technical phase, and the training of the individual to become a highly specialized expert. The introduction of rural economics and the spirit which it stands for was stated to be far more than the adding of two or three subjects of study to the agricultural course, but involved the socializing of the whole spirit and method of the college. The greatest need of American agriculture to-day was declared to be social leadership. It was argued that the college should assume this leadership and should train men and women for the service. A great enlargement of extension work among the farmers was advocated in order to teach the people who can not come to the college.

An address was delivered by Director William Saunders, of the Central Experimental Farm at Ottawa, Canada, on 'The Upbuilding of Agriculture.' This reviewed the development of agricultural education and experimentation in the United States and in Canada, and noted many of the material results of the experimental work in Canada and British Columbia, especially in the introduction and improvement of cereals by selection and breeding.

SECTION ON COLLEGE WORK AND ADMINISTRATION.

The program of this section included

some of the problems of livest interest to the land-grant colleges, and the discussion served to clarify the views on a number of important points.

The question as to how far the land-grant institutions should engage in teaching elementary subjects not generally recognized as belonging to the collegiate curriculum, was opened by a paper by President W. O. Thompson, who justified bringing the elementary instruction quite low down, on the ground of the lack of proper training in the rural schools, and also commended the short courses. Dr. R. H. Jesse, of Missouri, took the opposite view, and maintained that the remedy for the condition lay in the improvement of the public school system by the introduction of agricultural studies. While this was acknowledged to be the long way, as changes of this sort are slow of realization, he believed it to be the right way, which would justify itself in the long run. He disapproved of the establishment of agricultural high schools or preparatory departments for the agricultural colleges, but thought that the college of agriculture should rest on the public school system. Professor L. H. Bailey, of Cornell University, took a middle ground upon this question, holding that while these forms of elementary instruction do not properly belong in the college and are a temporary expediency, they are entirely warranted by the fact that the land-grant colleges do not at present articulate with the common schools. He believed that the final issue would be to prepare the public schools to prepare for the land-grant colleges, as they now prepare for the colleges of arts and sciences; but as this will occupy many years, perhaps a generation, he believed that the pressing problems of to-day must be taken care of, and on that ground defended the short and low-grade courses as temporary expedients.

Other speakers presented the local difficulties in confining the instruction to a four-year course, and maintained that the short courses had first aroused genuine interest and confidence in agricultural education, and that the more elementary grades of work did not obscure the college course. Under present conditions there is a large body of young men who are not and can not be prepared to enter the regular college course, and for these young men, who come to the college in increasing numbers, elementary and short courses were demanded.

The discussion of this question was continued in a paper by President J. L. Snyder, of Michigan, upon the subject 'What Can and Should be Done to Increase the Interest in and Appreciation for the Agricultural Side of Technical Training.' President Snyder urged that the courses in agriculture must be technical, and that the agricultural department must have equal advantages in the way of equipment, teaching force and buildings, with the other departments of the college or university. Short courses were advocated for those unable to take the longer courses. The speaker described what was done in Michigan to arouse interest in the agricultural work by maintaining close relations with the public schools, advertising the institution in various ways, and running excursions to the college during August, which the past year were attended by about 8,000 people.

Dean Davenport, of the University of Illinois, urged the need of differentiation of the subject of agriculture, and a larger number of instructors to cover different phases of the subject. Great progress has been made in this direction at a number of the institutions, but in many cases the teaching force was thought to be entirely inadequate. He made the point clear that the number of men to be taught should not be the unit in manning the staff of the agricultural department, as it has often been

in the past, but that the true unit should be the subject itself. He pointed out that the University of Illinois now has more teachers in agriculture than it had students five years ago, and that as soon as the number of instructors was doubled the number of students doubled. He expressed the belief that the interest in agriculture on the part of the students was usually about in proportion to the number of instructors in that subject, and that greater differentiation and increased provision for teaching the various branches of agriculture would meet with the same result everywhere that it did at his institution.

A discussion of the degrees which should be given on the completion of the undergraduate courses in agriculture in the land-grant colleges, led by President G. A. Harter, of Delaware, brought out considerable difference of opinion, some contending for the B.S. and B.A. degrees, while others advocated the degrees B.Agr. and B.S.A. for the agricultural students, as more definitely expressing the courses which they had pursued.

The question as to the intent and purpose of the Morrill Act in regard to military instruction was introduced by a paper by President M. H. Buckham, of Vermont. The special interest in this subject has grown out of General Order 65 issued by the War Department, which prescribes the amount of military instruction which the officers detailed to the land-grant colleges for this duty are expected to require. Some of the institutions have found themselves unable to comply with these requirements, and as a result the detail has been withdrawn. President Buckham suggested that less emphasis be placed on the manual and technical branches of military training and more upon the intellectual topics in the military art, since the students at these land-grant colleges 'take military tactics as a part of a liberal education, not to fit them to serve as enlisted men.' The quite lengthy discussion following this paper showed that with the general advocacy of the importance of military instruction called for by the Morrill Act, there was a quite general dissent from the present requirements of the War Department; and the executive committee of the association was finally instructed to present the views of the association to the authorities at Washington.

SECTION ON EXPERIMENT STATION WORK.

This section considered the general subject of the breeding and improvement of plants and animals, and held a conference on the question of the amount of teaching which it is desirable for station workers to do.

The development of knowledge regarding methods of breeding plants and animals, and the working out of some of the underlying principles, were presented in a paper by Professor W. M. Hays, who expressed a strong belief in the importance of systematic work in breeding and its great commercial application.

Dr. T. L. Lyon, of Nebraska, spoke upon 'Improvement in the Quality of Wheat,' describing the methods which he is working out in this line as distinguished from selection for yield alone. Since a high yield and high nitrogen content do not necessarily go together, it was pointed out that there is danger in selecting wheat for yield alone that the quality will be injured, and hence it was maintained that the quality should be taken account of in breeding or selecting for yield.

Professor H. Snyder, of Minnesota, called attention to the difference in value of wheat for various purposes, and the lack of standards; and on his motion a committee of three was appointed on standards for determining the value of cereals.

In a paper on 'Animal Breeding,' Professor C. F. Curtiss, of Iowa, reviewed the

work which is now being undertaken in animal breeding at the experiment stations of this country, and made some suggestions for work in that line.

In the conference upon the subject of 'How Much Teaching, if Any, is it Desirable that a Station Worker Should Do?' there was a lively discussion and a free expression of opinion, which seemed to be very largely in one direction. In opening the discussion Dr. H. P. Armsby, of Pennsylvania, showed that according to the latest statistics about 54 per cent. of the experiment station workers now do more or less teaching in the agricultural colleges, and that the tendency seemed to be toward an increase. He expressed doubt as to the advantage to the station man of doing college work, and he held that at all events it should be small and of advanced character. He believed that in this agricultural work a man should be chiefly either a teacher or an investigator, and maintained that, to a certain extent, the two kinds of work call for a different attitude of mind and the use of a different set of faculties.

Dr. W. H. Jordan held that the advantage of teaching, from the standpoint of the station man, depended quite largely upon the kind of teaching to be done, which in the case of the agricultural colleges is very largely the teaching of fundamentals. Such teaching he held to be of no advantage to the investigator, although he conceded that a small amount of teaching of an advanced character, along specialties with which the investigator is dealing, might prove advantageous.

It developed from the discussion that the plan of requiring this dual service from station men was regarded as largely one of expediency, and that the requirement of too much teaching from men holding important positions on the station staff had an unfavorable effect upon the general character of the station work. It was urged that the teaching should be so arranged on the college schedule as to interfere as little as possible with the time of the station worker, and that the tendency should be in the direction of restricting the amount of teaching and limiting it to advanced work. The discussion served to enunciate anew the true function of the experiment station as an institution primarily for the higher grades of experimentation and research, and emphasized more strongly than ever before the great need of a sharper differentiation of its work and its corps of workers from the instruction department of the college.

The extent to which specialization and equipment for agricultural instruction and investigation are being carried was exemplified at the Iowa State College at Ames, where the convention spent an interesting and profitable half-day as the guests of the institution. Here the large amount of live stock kept primarily for instruction purposes (over thirty head of horses of various breeds and types), the new pavilion for stock and grain judging, the well-equipped new department of farm mechanics, the commodious soils laboratory, the new dairy building in process of construction, and the plans for the new agricultural building to cost from $250,000 to $300,000, as well as the other departments of longer standing, were typical of the rapid advancement which is making in the material equipment for agricultural education, which will place that department on a par with engineering at the better institutions.

The officers of the association elected for the ensuing year were as follows:

President—E. B. Voorhees, of New Jersey.

Vice-Presidents—J. C. Hardy, of Mississippi; K. L. Butterfield, of Rhode Island; C. D. Woods, of Maine; E. R. Nichols, of Kansas, and E. Davenport, of Illinois.

Secretary and Treasurer—J. L. Hills, of Vermont.

Bibliographer—A. C. True, of Washington, D. C.

Executive Committee—H. C. White, of Georgia; J. L. Snyder, of Michigan; W. H. Jordan, of New York; C. F. Curtiss, of Iowa, and L. H. Bailey, of New York.

Section on College Work and Administration—Chairman, R. W. Stimson, of Connecticut; Secretary, K. L. Butterfield, of Rhode Island.

Section on Experiment Station Work—Chairman, H. J. Patterson, of Maryland; Secretary, M. A. Scovell, of Kentucky.

E. W. Allen.

SCIENTIFIC BOOKS.

The American Natural History, A Foundation of Useful Knowledge of the Higher Animals of North America. By William T. Hornaday. New York, Charles Scribner's Sons. 1904. 8vo. Pp. xxv + 449.

The object of this book is to make nature available to laymen; it is also particularly addressed to teachers and parents. It is intended to be plain, practical and direct, as well as systematic and scientific. The author has evidently striven (generally with good effect) to make his exposition simple and lucid, his diagrams and synopses mnemonic, his illustrations life-like, his style lively and personal. He has a proper abhorrence of mere closet naturalists as such, and much of the information presented he has won at first-hand during many years' experience as a field naturalist in America and the far east, and as director of the New York Zoological Park. Accordingly, we find here much practical and economic zoology, invaluable matter on the extinction of American species, and the setting right of many ancient and silly myths. As the field covered includes all the principal types of vertebrates found in North America, it is not to be wondered at that slips are to be detected here and there; and in regard to the author's ideas on classification we shall offer a few criticisms.

Clear exposition is exhibited in many sections of the book, notably in the chapter on the rodents. The genera and species are sketched in a manner that should be easily intelligible to the layman and useful to the general zoologist. The chapter dealing with the ruminants is also noteworthy. There are numerous excellent synopses arranged in brackets, and for each class of vertebrates there is a chart of the different orders. Admirable charts show the distribution of mountain sheep, elk, etc., and a convenient map of North America appears on the inner back cover.

The drawings, while of uneven merit, are full of life and action and have good teaching value. Many of them, as, for example that which represents the harpooning of a twenty-foot eagle ray, will surely arouse the enthusiasm of young readers.

Certain groups, *e. g.*, the ducks, are illustrated with great fullness. There are many photographs from life, among those of especial merit being the well-known photograph by Umlauff of an old male gorilla, the photograph by Professor Nathorst of a herd of wild musk oxen, the photographs of the white-tailed deer, bison, owls, pelicans, flamingos, condors, etc., and several of crocodiles; a most remarkable one is that by Beck showing a great multitude of the marine iguanas of the Galapagos gathered together on a rocky shore. There are excellent photographs of the principal snakes; and among Amphibians one photograph shows the northern tree frog with the vocal sack protruded.

The author aims to amuse as well as to instruct, as shown in the following typical passage:

> Whenever you see a brown-coated burrowing animal, the length of a small rat, but twice as thick, with a big pouch in the skin of each cheek, a swinish appetite, a set of long claws like burglars' tools on each fore foot and a most villainous countenance and temper you may know that it is a pocket gopher. The pockets in his cheeks are to enable him to carry extra large quantities of stolen potatoes and seeds.

It is regrettable that in the endeavor to be popular the author repeatedly ascribes human characteristics to those animals, such as pikes, for example, which, so far as we know, are utterly unlike man in their psychic constitution. The same straining for popularity also leads in a number of passages to sensationalism and 'rhetoric.'

Of the author's numerous first-hand observations of great value we may cite only the following:

An alligator seized a fighting enemy by one leg, and using his tail as a propeller, whirled himself round and round like a revolving shaft, until in about five seconds the leg was twisted off, close up to the body!

Very noteworthy is the incident of the entombed live frogs in Ceylon, which were dug up in the dry bed of what in wet weather was a shallow brook.

Of melancholy interest are the full accounts of the extinction of the bison, and of other species of birds and mammals, and of the threatened extinction of the mountain sheep, bighorn, antelope, etc., for the preservation of which the author gives practical suggestions. Fishing and the fishery industries receive considerable attention.

Many popular fallacies and myths are set right. Bats never 'get in your hair.' Certain bats, birds and rodents suspected of injuring the farmer are shown to be his best friends. The gila monster is not ferocious and its bite is not necessarily fatal. No snakes are slimy; the tongue of a snake is never capable of inflicting a wound or conveying poison. Rattle snakes add more than one joint a year to their rattles. The gavial and mugger crocodiles of India are harmless to man, and so are the American crocodiles and alligators.

Of the errors, misstatements, misinterpretations and omissions observed we may note the following: The 'Missing Link' question is discussed, without any reference to the *Pithecanthropus erectus*. Now, whatever may be thought of this remarkable fossil, it should at least have been mentioned. The flippers of the manatee are described as 'well-nigh useless,' except to a limited extent in assisting to convey the food to the mouth. But the manatees in the New York Aquarium may be seen any day using their flippers to good effect in swimming about leisurely. The manatee is further said to be compelled to live on aquatic plants because its molar teeth are weak—but this is probably 'putting the cart before the horse.' The unique horizontal action of the upper lip of the manatee when pulling food into the mouth is not mentioned. Good opportunities to teach the very simplest and most interesting facts of comparative anatomy are neglected. For example, it is nowhere pointed out that birds' wings are modified reptilian hands, bearing long feathers—a fact which might easily have been mentioned in the references to *Archæopteryx*—that in the several groups of aquatic mammals the flippers represent modified hands and feet; that in hoofed mammals, for purposes of speed, etc., the ancient five-toed foot has been, as it were, made over and cut down into the odd-toed and the even-toed types (the use of the term 'divided hoofs' simply confirms a common misconception); that the hoofs of ungulates are really highly improved nails, etc.

The female kangaroo is stated to transfer the young at birth to her pouch by means of her paws instead of by her lips as stated by Owen and other observers. The monotremes are regarded (p. 359) as bridging over the chasm between the classes of birds and mammals, a thoroughly discredited notion. The African ostrich is described as a worthy *descendant* of the moa. *Apteryx* is stated to be 'absolutely without wings,' although Owen, T. J. Parker and Pycraft have all described the wings in great detail; the wings are vestigial, it is true, but they retain an elaborate musculature, spiny remiges and an alar claw. The gills of *Ceratodus* (p. 381) are stated to be small and imperfect and 'of little use.' But this is quite contrary to the observations of Semon.*

Throughout the book a curiously artificial importance is placed upon so-called 'zoological rank,' whether 'high' or 'low.' The Cetacea (perhaps the most complexly organized of mammals) are considered to be 'low' because they lack hair and are fish-like in form. The Dipnoi, we are told, are the 'highest' among fishes because most like amphibians; the eels are very low *because* they lack scales and paired fins!

In classification the author apparently does not trouble himself to distinguish similarities due to analogous, parallel or convergent evolution from similarities due to blood kinship.

* 'In the Australian Bush,' pp. 92, 93.

Thus he finds it convenient to separate probably related groups such as the Pinnipedia and the Carnivora, *Polyodon* and the sturgeons, but, on the other hand, he thinks the orders Anseres, Steganopodes, Tubinares, Longirostres, Pygopodes, Impennes 'might well stand as a subclass—the web-footed swimmers.' Whatever mnemonic value there may be in his classification of the fishes (which is based chiefly upon visible external characters), it must be admitted that the scheme is arbitrary, not expressive of kinships and far from representing the present state of ichthyology. The physostomous and physoclistous orders are scattered about indiscriminately the electric eel (*Symbranchus*, which is almost certainly an eel-like offshoot of the characines) is cited as a typical example of the order Apodes; the Pediculates are widely separated from the spiny-finned group and placed next to the 'foot of the subclass of bony fishes,' which place of slight esteem is assigned to the eels and *to the sea-horse group!*

W. K. Gregory.

SCIENTIFIC JOURNALS AND ARTICLES.

The February number of the *Botanical Gazette* contains 'The theory of respiration,' by C. R. Barnes, being an address as retiring president of the Botanical Society of America, and published also in Science of February 17. —H. N. Whitford has begun a discussion of the forests of Flathead Valley, Montana, being the results of his work as a collaborator in the U. S. Bureau of Forestry. The paper discusses the conditions that determine the appearance and nature of the forests of that region, and inferentially the nature of the conditions of forest development in other regions.—Theo. Holm publishes a study of *Munroa squarrosa*, both from the standpoint of its general characters and its anatomy.—C. J. Chamberlain presents the view of a botanist as to alternation of generations in animals, his theory being that the egg with the three polar bodies constitutes a generation comparable with the female gametophyte in plants; that the primary spermatocyte with the four spermatozoa constitute a generation comparable with the male gametophyte in plants; and that all other cells in the animal constitute a generation comparable with the sporophyte in plants. His lines of evidence are the gradual reduction of the gametophyte in plants, with the constantly diminishing interval between the reduction of chromosomes and the process of fertilization; and the phenomena of chromatin reduction in both animals and plants.—W. F. Ganong, in continuing his descriptions of new precision-appliances for use in plant physiology, describes an autographic transpirometer, an adjustable leaf clasp, and a leaf-area cutter.

The February number of the *Journal of Nervous and Mental Disease* opens with an article by Dr. Morton Prince, of Boston, on the course of the sensory fibers in the spinal cord as evidenced by a case of section of the cord. Dr. Prince discusses the function of the posterior columns with a leaning toward the view that they are largely for the conduction of muscular rather than tactile sense, and that at least one of the paths of conduction of tactile sense is in the lateral part of the cord. He goes over the reports of various experiments on animals, and then presents very carefully the case in point, resulting from a brawl between a couple of Italians and amounting practically to a vivisection experiment on a human being. Lack of space prevents giving his conclusions in full, but among them might be noted: It is proved that tactile sensations are conducted by other paths than the posterior columns, and this is probably although not positively true of pain as well. A path for sensibility must cross the cord. In the second article Dr. Frank R. Fry, of St. Louis, reports two cases of syphilitic disease of the cervical spine, belonging to a type characterized by a stiff neck with one or more points of tenderness on deep pressure, severe neuralgic pains, often not sharply localizable, no objective sensory changes, and no paralysis. Dr. F. X. Dercum, of Philadelphia, reports a case of trauma of the foot of the second frontal convolution, followed by ataxia, nystagmus and epilepsy, which improved after surgical interference. The October meeting of the Philadelphia Neurological Society and the November meeting of the New York Neuro-

logical Society are reported. The 'Periscope' includes abstracts of the following periodicals: *Neurologisches Centralblatt, Journal de Neurologie, Allgemeine Zeitschrift für Psychiatrie, Journal of Mental Science, Archives de Neurologie,* and selected articles from miscellaneous journals. T. S. Clouston's 'Clinical Lectures on Mental Diseases' and 'Traité de Medicine,' Vol. IX., Diseases of the Nervous System, are reviewed.

SOCIETIES AND ACADEMIES.

THE GEOLOGICAL SOCIETY OF WASHINGTON.

The Red Beds of Southwestern Colorado: WHITMAN CROSS and ERNEST HOWE.

During the areal mapping of the Ouray quadrangle, on the north side of the San Juan Mountains last season, a notable angular unconformity was observed immediately below a peculiar limestone conglomerate which has long been known to carry fragmentary remains of dinosaurs and crocodiles, with occasional plant and invertebrate forms, all of Triassic types (see Telluride and La Plata folios). Within a distance of two or three miles this Triassic conglomerate is seen to transgress the edges of 1,200 feet or more of unfossiliferous conglomerates, sandstones and shales, of typical Red Bed character, and several hundred feet of the Hermosa formation—Pennsylvanian Carboniferous. The Triassic beds are here but 50 to 200 feet thick, the La Plata Jurassic sandstone resting unconformably upon them.

This unconformity below the Trias shows that the major portion of the Red Beds section of the San Juan country is Paleozoic and the authors provisionally refer that portion to the Permian, and propose the name Cutler Formation for it, the Triassic Red Beds retaining the name Dolores, in accordance with the original definition of that formation.

The significance of this unconformity in interpreting the Red Beds sections of other parts of Colorado and the western plateau country was briefly discussed. This paper was read by title at the winter meeting of the Geological Society of America and will be offered for publication in full in the *Bulletin.*

Cause and Periods of Earthquakes in the New Madrid Area, Missouri and Arkansas: MYRON L. FULLER.

The term New Madrid earthquake is applied to a series of shocks beginning late in 1811 and continuing to the early part of 1813, constituting one of the most remarkable examples of incessant quaking in a region far from any volcano for a period of many months. The shocks, though felt throughout nearly the whole of the country then settled, were most severe in southeastern Missouri, northeastern Arkansas and western Tennessee. Along the Mississippi there is said to have been a broad dome-like uplift of some twenty feet, while both to the east and west the land was depressed, forming the broad 'sunk land' districts. The uplift resulted in the drainage of many lakes and bayous, while the depression gave rise to basins into which waters flowed, killing the existing timber. Among other characteristic features of the earthquake was the opening of immense cracks, often several feet across and many feet in depth, and the formation of craterlets, through both of which large amounts of lignite-bearing sands were ejected, probably giving rise to the broad areas known as sand-slews where the surface, even to-day, is in places a barren, sandy, timberless waste, upon which only weeds will grow. The submerged stumps, slews, craterlets and cracks were still visible in 1904 when a trip was made to the region by Professor E. M. Shepard, C. B. Bailey and the speaker. Professor Shepard, who gave much attention to the cause of the earthquake, believes that the conditions are such as would result from the undermining action of ground waters under artesian pressure and which are thought to have escaped in the past, as possibly at present, along some of the streams by springs bringing up sand and lignite. The equilibrium being destroyed by a readjustment of some Ozark or other fault, cracks were formed and sand and water ejected in large amounts, permitting the settling described. The speaker, however, believes that there was no preliminary undermining, but that the sinking was brought about because of the extrusion at the time of the

quake of large amounts of the quicksand underlying the clay, which, when saturated with water, flows almost as readily as water alone. Observation on the ages of trees in the cracks brought out the fact that some fissures were formed a hundred years or more before the recorded quake, while inquiry of the inhabitants shows that earthquakes are still of almost annual occurrence and are accompanied by similar but less pronounced phenomena than those accompanying the quake of 1811, indicating that the latter was simply an acute stage of a readjustment which has long been going on and is still in progress.

Some Crystalline Rocks of the San Gabriel Mountains Near Pasadena, California: Ralph Arnold, Washington, D. C., and A. M. Strong, Independence, California.

The San Gabriel Mountains, comprising an area of about twelve hundred square miles, extend for fifty miles in a west-northwesterly direction from Cajon Pass in San Bernardino County, to the Santa Clara River in Los Angeles County. Considerable divergence of opinion regarding the age of the chain has prevailed among previous writers, but it is probable that it received at least the greater part of its elevation during late Eocene or Oligocene time.

The southern range of the chain, the Sierra Madre, is composed principally of granodiorite and gneiss, with some associated quartz-monzonite and gabbro and intruded aplite, quartz-hornblende-porphyrite and diabase porphyry. The central portion of the mountains consists of somewhat coarser grained granites and granodiorites with intruded aplite, micropegmatite, etc.

The granites described are of the biotite variety and are found in the central part of the chain. The granodiorites consist of two facies, a fine-grained hornblende-bearing variety from the Sierra Madre and a somewhat coarser grained variety containing porphyritic orthoclase from the central mass. These granodiorites differ from those found in the Sierra Nevada of central California by being on the average finer grained and having less quartz, titanite and zircon. Gabbro, consisting mostly of hornblende, but also containing a little plagioclase, is found in small masses or dikes throughout the whole area. Aplite is found over the whole region in question, while micropegmatite was found only in the central portion of the chain. Quartz-hornblende-porphyrite and diabase porphyry occur in dikes in the southern range. Of the metamorphic rocks, hornblende-diorite-gneiss is by far the commonest. It and some biotite-granite-gneiss are associated with the granodiorites and quartz-monzonites of the Sierra Madre. Hornblende-schist and garnetiferous schist, found by the writers only in the southern range, complete the list of crystalline rocks described.

The Question of the Origin of the Natural Mounds of Louisiana: A. C. Veatch.

Of the many theories of origin suggested for these mounds three deserve the most careful attention: (1) the spring and gas vent theory, (2) the dune theory and (3) the ant hill theory.

In the spring and gas vent theory it is argued that the gas produced by the decay of the large amount of vegetable matter buried in the coastal plain strata has, with the artesian water associated with it, brought to the surface fine sand and built up low cones. Small cones are now forming in this manner at many points in the coastal plain, and they were pointed to as proving this hypothesis. The fatal objection to this theory is that entirely identical mounds are found in Indian Territory on flat plains underlaid by highly inclined carboniferous shales and sandstones, where the substructure clearly lacks the elements required by this hypothesis.

The dune theory is based on the resemblance of these mounds to the low dunes which collect in the semi-arid region of the west about clumps of low vegetation. The objection to this theory is the great irregularity of wind-made features and the very notable uniformity in size and exact resemblance one to another of these natural mounds of the south central United States over an area at least 300 miles wide and 500 miles long. It would seem that in so large an area a wind origin would involve a greater variation in size than has been

observed, and necessitate the presence of occasional dunes, or lines of dunes, of noteworthy size whose origin could not in any way be doubted.

In the ant hill theory two possible lines of development were suggested: (1) That the mounds are the work of the *Atta*, or leaf-cutting ants, (2) that they are the remains of hills of a mound-building variety of white ants, the termites. According to Professor W. M. Wheeler, *Atta* hills in western Texas reach a diameter of forty to fifty feet and a height of one to two feet; and Mr. E. A. Schwarz, of the National Museum, reports that the *Atta* hills in Cuba often reach a height of ten to twelve feet and a diameter several times as great. These occurrences are considered to add greatly to the possibility of an ant origin.

Regarded as the work of mound building termites, which are now restricted to the tropical regions, these mounds suggest a warmer and moister climate. Modifications such as those which permitted large elephants, camels and animals of the sloth and armadillo families to live in this region would also have permitted these now similarly restricted mound-building termites to do the same; and the causes which resulted in the extinction of the larger animals would also, though at a later date, have destroyed the mound-building termites.

Of the theories of origin yet suggested none are entirely satisfactory, and the dune and ant hill theories are the only ones well supported. If either of these hypotheses is correct the mounds are indications of important climatic changes in very recent time. It was suggested that the matter should be approached by the careful excavation of a number of these mounds at widely different points in order to fully determine the relation of the mounds to the beds which underlie them and to the soil surrounding them.

H. F. BAIN,
Secretary.

CLEMSON COLLEGE SCIENCE CLUB.

THE fiftieth regular meeting of the club was held Friday, December 16. By way of special observance of the occasion, Professor M. B. Hardin, the first president of the club, gave informally a brief account of the organization and early days of the club, and recounted some of the more interesting of the former programs.

Professor T. G. Poats discussed 'Recent Advances in Astrophysics,' dwelling particularly upon those made possible by the use and improvement of the spectro-heliograph.

Professor Harmon Benton, under the head of 'Economic Possibilities of the May-pop,' gave an account of his preliminary experiments in improving the wild may-pop (*Passiflora incarnata* L.) by increased fertility of soil, selection and crossing upon the edible species of *Passiflora*. Results to date indicated that the plant responded readily to improvement, and its development into an economic fruit can be predicted with no little certainty. These experiments will later be published as a bulletin of the South Carolina Experiment Station.

Dr. P. H. Mell gave an account of the Des Moines meeting of the Association of American Agricultural Colleges and Experiment Stations and Professor C. E. Chambliss reported on the boll-weevil convention at Shreveport.

The fifty-first regular meeting on Friday, January 20, was given up to reports from those who attended the Philadelphia meeting of the American Association: Dr. P. H. Mell, Professor P. T. Brodie, Professor C. E. Chambliss and Dr. Haven Metcalf, reporting on the work of the sections and affiliated societies in geology, engineering, entomology and botany, respectively.

HAVEN METCALF,
Secretary.

THE NEW YORK ACADEMY OF SCIENCES. SECTION OF BIOLOGY.

AT the January meeting Dr. W. M. Wheeler assumed the chairmanship for the year 1905. Papers were presented by Dr. Esther F. Byrnes and Dr. Wheeler.

Dr. Byrnes described 'Transitional Stages and Variations in some Species of *Cyclops*.' The species *C. signatus* occurs sexually mature in morphologically incomplete stages. It

is then characterized by eleven antennal segments instead of the adult number, seventeen; and is comparatively small in size and pale in color. Large numbers of adults of the type *C. viridis* show striking variations in the armature of the swimming feet. Similar antennæ and fifth feet are correlated in one type of individual with the swimming feet of *C. parcus;* in another form with *C. viridis* (var. *Americanus*) and in another with *C. brevispinosus.* Occasionally serial and lateral variations combine the swimming feet of *C. parcus* and *C. brevispinosus* in the same individual. These facts, together with the frequent replacement of setæ by spines, the constant association of the forms and their occasional sequence in small aquaria, indicate a very close relationship among the species observed and suggest that they are transitional forms in the development of a single species.

Dr. Wheeler described the structure and ecology of many 'ants that raise mushrooms,' giving special attention to the species of Texas and Mexico, where his own studies of these ants were made. Numerous lantern slides illustrated this lecture; and at its close many slides from photographs of ants kept in captivity by Miss Adele M. Fielde were exhibited.

M. A. Bigelow,
Secretary.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY.

The 158th meeting of the Elisha Mitchell Scientific Society of the University of North Carolina was held in the chemical lecture room, Tuesday evening, February 14, at 7:30 o'clock. The program was as follows:

Dr. R. H. Whitehead: 'Mode of Infection of the Hookworm Disease.'

Professor Archibald Henderson: 'The Mystic Hexagram.'

Professor C. L. Raper: 'Statistics of Cotton Manufacturing in the South.'

Alvin S. Wheeler,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

MONT PELÉE SIVE MONT PELÉ.

It is a curious coincidence that geologists who affect the title of 'Mont Pelé' in preference to the formal appellation of Pelée, should have associated, so far as identity of names is concerned, the tutelary divinity of volcanoes amongst ancient Hawaiians with the island of Martinique. We are assured, however, that the innovation has not been made with the idea of reverencing the goddess, but out of regard for rules of gender, Pelée being considered an adjective adopted from the Spanish, as one contributor to Science has it, or from Carib speech, according to another. Admitting either of these explanations, it is easy to see that Spaniards or Caribs must also have had a hand in christening an island by the same name off the coast of France.

In reality, Pelée has continued to be a word of good and regular standing in the French language since the time of the Norman Conquest, the expression of 'une vergé pelée' occurring in the 'Chanson de Roland,' supposed to be of the early eleventh century. Strictly speaking, the word is a past participle of *peler,* which, with the co-derivatives of *pelare* in Italian, *pelar* in Spanish, and *peel* in English, comes from the Latin *pilare.* Now it happens that large numbers of past participles have become preserved in modern French as substantives, some masculine, but the majority feminine—as for instance, *allée, mêlée, gelée, fumée,* etc. And we have the authority of La Fontaine, in his 'Fables,' to say nothing of colloquial usage both in French and German, for considering the word meaning bald as a noun.

Applying this principle to place names, Pelée may be regarded as having acquired the force of a substantive, like our own 'Rockies.' It is true that Rocky and Bald may connote the character of mountains, but the adjective force of these words becomes lost when they stand for geographical appellations. Indeed, names like Big Sandy, Vera Cruz, Jungfrau, Sacré-Cœur, and so on, are nouns pure and simple. By treating Pelée as a noun, we shall have the advantage of an invariable termination, thus doing away with a dual orthography, or the possibility of a triple, in case we were writing in German.

As regards the question of gender it may be remarked that in the case of geographical

nouns this is extremely arbitrary; and, moreover, in all inflected languages, words very often undergo transformation in gender during course of time. Le Péloponnèse, for instance, has a feminine termination, but is of the masculine gender; and Galilée may be of either gender. Val, feminine in the Latin *vallem,* and still feminine in French proper nouns, has become masculine by common usage, taking the plural *vaux* by analogy with *mal, cheval,* etc. Some words, like *sang,* are masculine in certain combinations, and feminine in others. Finally it can hardly be claimed that the form 'Mont Pelée' does violence to a language which authorizes us to place the feminine article before *bon-bec,* and the masculine before a variety of words like *rouge-gorge, rouge-queue, cent-garde, grand' croix, patte-pelu,* etc.

C. R. EASTMAN.

HARVARD UNIVERSITY.

THE METRIC FALLACY.

TO THE EDITOR OF SCIENCE: In a recent article in SCIENCE on the discussion of the metric question in the House of Lords, Dr. Seaman repeats with approval the claim as to the great saving of time that would be accomplished in school by the use of the metric system. This claim has been one of the chief supports of the metric cause for generations, and has remained practically unchallenged except by a general denial. The forms in which is was presented in the House of Lords last February and in the report of our House Committee on Coinage, Weights and Measures in 1902, are so typical of this claim that both are given here:

Lord Belhaven, in House of Lords, February 23: "There is a great waste of time in the education of children, through the learning of the arithmetical tables and their application. Out of 221 school-masters consulted, 212 replied. One hundred and ninety-seven stated that there would be a considerable saving of time if the metric system were introduced; of these, 161 estimated the saving at one year; 30 estimated it at two years; and six went so far as to estimate it at three years."

Report of the Committee on Coinage, Weights and Measures to the House of Representatives, April 21, 1902: "Estimates made by the Department of Education and others show that the work of at least two thirds of a year in the life of every child would be saved by the adoption of the metric arithmetic. * * * Teachers and pupils alike unanimously testify as to the ease with which the system is taught and learned and the facility with which it is applied to the problems which in ordinary arithmetic are complex and difficult to solve. When we consider that there are over 15,000,000 school children in the United States being educated at a public cost of not less than $200,000,000 per year, the enormity of the waste will be appreciated. In the lifetime of a single generation nearly $1,000,000,000 and 40,000,000 school years are consumed in teaching a system which is in harmony with that of no other nation of the world."

This argument has been reiterated with so much emphasis and with such a show of authority that it has unquestionably carried conviction to the minds of thousands. The opinions of experts regarding their own trade are ordinarily accepted by others. If educators say the metric system would effect a saving of one to three years in the school life of a child, why should it not be accepted as true?

Within a few weeks Frederick A. Halsey has applied the scientific method to the school children argument, and, in view of its general acceptance, with startling results. It is to him that I am indebted for the data on this point. In the report of the course of study for elementary schools, dated May 27, 1903, the board of education of New York city gave a time schedule for each study for the eight years. This schedule is based on 1,500 minutes per week, and the time allotted for all branches of mathematics amounts to 34⅛ weeks for the eight years. No reliable data is available as to the proportion of this time occupied in the study of weights and measures; 20 per cent. of the text-book on arithmetic, however, is occupied by the chapters on compound numbers, weights and measures. In order to be liberal to the metric cause we will apply this rate, 20 per cent., to the whole time, including that occupied with algebra and geometry. The total time devoted to the study of compound numbers, weights and measures during the eight years

of school life by this liberal estimate amounts to 6.8 weeks, from which the introduction of the metric system is to save from one to three years.

It would seem as if absurdity in advocating the metric system could go no farther. The exposure of this metric fallacy is not an occasion for ridicule, directed at Lord Belhaven, the House Committee on Coinage, or others who have accepted it in good faith. It is rather a cause of humiliation that such an absurd pretence regarding education should have been spread broadcast, not only without dissent from the schools, but with their enthusiastic approval. Have our educators become so accustomed to receiving and imparting information by mere authority that they have lost the power of analysis?

Dr. Seaman refers to the English system as 'the complex, irregular and barbarous system now in vogue.' Again, Professor J. H. Gore, of the Society for the Promotion of the Metric System, is thus quoted in *School Science:*

> We send consular representatives to every quarter of the globe for the express purpose of making possible an extension of our foreign commerce, and then busy ourselves in an attempt to make such commerce impossible, and retain a system of weights and measures which adds to our own difficulties and makes us mere barbarians to the more progressive nations.

The metric advocates, while accepting the wild and extravagant claims for the metric system, treat our own system with contempt. Nevertheless, the scientific method that exposes the hollowness of their claims also proves that the English system is intrinsically the best and, as far as uniformity is desirable, the most uniform system on earth. It is the standard of the richest portion of the earth's surface; of the two most enlightened, populous and powerful nations on earth; and of the only nations that control vast unsettled regions to accommodate the increase of their population. It is the standard of the past and present, and the world trend points to it as the standard of the future.

Dr. Seaman states that:

> Any one who will take pains to inquire of any of the thousands of immigrants that come among us, will convince himself that the metric system is the principal system in actual use in trade and commerce in European countries.

For two years I have been taking pains to do this very thing, and have been convinced by it that the European immigrants know very little about the metric system. A few typical examples: An Italian from Naples was acquainted with the 'kil,' but knew nothing about the meter, his ideas of length being based on the *can,* which he informed me was something less than eight feet. A Swede said that while the metric system was used in the stores in his country, the *tunland* and *hemend* were used for measuring land. An Austrian was ignorant of metric measures, but was familiar with the *pfund* and *zoll.* An educated German informed me that the metric system was the only one used in Germany, but added: "Aber das Volk braucht die alten Masse." A Greek had heard that the 'kil' was used in Italy, but did not know what the metric system was. His standard of weight was the *oka.* Greek land, he said, was measured by the *stremma.* When asked how cloth was measured in Greece, his wife replied: "By the *pik.*"

With all it was the same story, ignorance of metric units, familiarity with their old standards. None expressed any ideas of measure to conform with those of any other nationality until I talked with a Russian. Scratch a Russian and you will find an Englishman—in measures. His standards of linear measurement are either the same as or commensurable with the English inch. His *duim* is our inch; his *archin* is 28 inches; his *verschock* is 1¾ inches; his *sagen* is 7 English feet; and his *verst* is 3,500 English feet. Two hundred years ago, Peter the Great, while in Holland, was impressed by the superiority of the English vessels that visited the Dutch ports. This led him to visit England, where he worked as an ordinary carpenter in the English shipyards. When he returned to Russia he took back with him four mast makers, four boat builders, two sail makers, and about twenty other workmen to teach their trade to his people. Thus without coercive laws, but peacefully and naturally, the English system was introduced into Russia, and to-day is the

basis for all linear measurements throughout that vast empire. The inch carried by the English settlers to Jamestown in 1607, and that taken by the English carpenters to St. Petersburg in 1698 were the same; and the Russian emigrant, landing in America in 1905, finds the linear measurements of his new home commensurable with those of the land he has left.

Compare this uniformity of popular usage with the chaos of incommensurable standards wherever the metric system has been forced by law into conflict with the old standards of the people. One is the result of English evolution; the other, of French revolution.

SAMUEL S. DALE.

BOSTON, MASS.,
January 17, 1905.

SPECIAL ARTICLES.

DETERMINATE MUTATION.

AMONG the significant results obtained by Professor de Vries in his breeding of *Œnothera lamarckiana*, and by Dr. MacDougal breeding the same species in the New York Botanical Garden, there is one feature which seems to have attracted less attention than it may deserve. Most of the seven mutants observed by de Vries, and of the thirteen seen by MacDougal, have appeared more frequently than would be natural were the mutations wholly fortuitous and indeterminate.

In the Amsterdam garden the mutant *albida* appeared in four different generations from *lamarckiana* parents, previous to 1902, 15 *albida* appearing in one generation, 25 in another, 11 in another and 5 in another. *Nanella* appeared 5 times in one generation, and in other generations, respectively, 3, 60, 49, 9, 11 and 21 times. *Lata*, *oblonga* *rubrinervis* and *scintillans* appeared frequently.

In the fourth generation along with 14,000 *lamarckiana* plants there appeared 41 *gigas*, 15 *albida*, 176 *oblonga*, 8 *rubrinervis*, 60 *nanella*, 63 *lata* and 1 *scintillans*, all bred from *lamarckiana* seed. In the fifth generation, similarly bred from pure *lamarckiana* seed, among 8,000 *lamarckiana* plants were found 25 *albida*, 135 *oblonga*, 20 *rubrinervis*, 49 *nanella*, 142 *lata* and 6 *scintillans*. In the fourth generation one plant in 80 was *oblonga*. In the fifth generation one plant in 60 was *oblonga*. De Vries himself says: "A species, therefore, is not born only a single time, but repeatedly, in a large number of individuals and during a series of consecutive years."

De Vries writes of *Œnothera oblonga:*

Meist etwa sechsten Blatte sind die jungen Pflänzchen dieser Art mit Sicherheit zu erkennen, also etwas später als *O. lata* und *O. nanella*, und wesentlich früher als *O. rubrinervis* und *O. scintillans*. Die Blätter sind schmal, lang gestielt, ziemlich scharf vom Stiele abgesetzt, mit breiten, blassen, auf der Unterseite oft röthlichen Nerven. In Aussaaten sind die *O. oblonga* nur bei sehr weitem Stande früh und gleichzeitig zu erkennen, aber wenn man in den Versuchen von Zeit zu Zeit die unzweifelhaften *oblonga*-Exemplare auszieht, so zeigen sich die Merkmale bald in weiteren und weiteren Individuen, ohne dass diese dazu viel Raum brauchten.

In den ausgepflanzten Rosetten erhält sich die angegebene typische Blattform. Einige Exemplare treiben Stengel, andere werden zweijährig. In beiden Fällen bleiben die Pflanzen niedrig, erreichen kaum 1 m Höhe und sind auffallend kleiner, als die in derselben Weise cultivirten Exemplare von *O. Lamarckiana*. Die einjährigen verzweigen sich wenig. Die Zweige bleiben meist kurz, Die Aehren sind dicht mit Blüthen und Knospen besetzt; die Blüthen kleiner als bei *O. Lamarckiana*, sehr arm an Blüthenstaub und nur ganz winzige Früchtchen mit wenigen Samen aussetzend. Die zweijährigen verzweigen sich kräftiger und sind mit Pollen reichlich versehen; sie bilden zwar kurze, aber dicke Früchte, welche eine reiche Samenernte geben.

Bei fortschreitender Blüthe erkennt man die *oblonga*-Exemplare schon von Weitem an den dichtgedrängten, aber kleinen unreifen Früchten.

This mutant, therefore, differs from the parent species, *lamarckiana*, not in a single feature, but in an elaborate complex of characters. The other mutants likewise are distinguished from *lamarckiana* by a complex of characters rather than by a single feature. Speaking of the contrast between reversions and progressive mutations, de Vries says:

> * * * ordinarily they [reversions] deviate from the species in but a single character * * * . Quite different from this are the mutations of *Œnothera*. Recognizable as seedlings, as rosettes differing in shape, edge and color of the root-leaves, and later with stems differing in structure and mode of branching, agreeing in the flowers, varying in the fruits, they possess a type entirely their own * * * .

The mutations can hardly be entirely fortuitous if, for several generations, out of every thousand offspring of pure *lamarckiana* parents, there appear more than ten plants marked by the particular complex group of characters which designate *oblonga*. Were *oblonga* demarcated from *lamarckiana* by but a single character it would be remarkable to find it appearing repeatedly and in such numbers. When we remember that it is defined by an extensive series of characters differentiating it from *lamarckiana* and from all the other mutants observed, are we not led to the conclusion that mutation in *Œnothera lamarckiana* is not wholly fortuitous, but is to a degree predetermined; that there is some tendency to the production of the *oblonga* and other types in numbers much greater than would be secured by purely fortuitous and indeterminate mutation?

It seems of much interest that the evidence from paleontology in favor of determinate variation (or mutation) should be borne out by such careful observations as those of de Vries in so different a field of research.

I confess I do not quite understand Professor De Vries's statement—'In my experiments the mother species mutates *in all directions* [italics mine], in nearly all organs and characters, as well as for better or worse." I can not see that the published descriptions of his observations do show mutation in all directions. They seem to show rather the continued reappearance of but a few (7) distinct types of mutation. To be sure, MacDougal finds thirteen instead of seven of these mutants from *Œnothera lamarckiana*, but this is far from mutation in all directions. De Vries apparently meant merely to urge that the mutations were in several different directions and were such as could hardly be due to direct environmental influences, and not to claim that the mutations were purely fortuitous and indeterminate.

Maynard M. Metcalf.
The Woman's College of Baltimore,
January 18, 1905.

CURRENT NOTES ON METEOROLOGY.

THE TEACHING OF METEOROLOGY.

Professor Cleveland Abbe, of the U. S. Weather Bureau, delivered an address upon 'The Introduction of Meteorology into the Courses of Instruction in Mathematics and Physics,' before the Physics and Mathematics Section of the Central Association of Science and Mathematics Teachers, on November 26 last. This address has now been reprinted, and constitutes a strong plea for more instruction along meteorological lines in various courses in mathematics and physics in which meteorological problems could well be dealt with. Professor Abbe regards meteorology 'not so much a matter of observation and generalization as matter of deductive reasoning,' and rightly believes that our meteorological studies have *approached*—he does not say *reached*—the limit of what is likely to be discovered as the result of inductive processes. He does not suggest the introduction of a new study into the already overcrowded curriculum of schools and colleges, but he would have problems in mathematics and physics selected from among the many phenomena of the atmosphere which need investigation. Thus, among a few special subjects which are enumerated, we find the simpler applications of trigonometry in the determination of cloud heights and velocities, by means of the simpler methods, such as Lambert's and Feussner's, and by the use of the theodolite, photogrammeter and nephoscope; the theory of the wet bulb thermometer; the hypsometric formula of Laplace; thermometer corrections; the formation of a waterspout by Weyher's method; and the study of the wind velocity, pressure, temperature and dimensions of the cloud column. Professor Abbe's paper is suggestive, and points the way toward a considerable possible extension of sound meteorological education by utilizing the mathematical and physical machinery already in operation.

LABOR AND HEALTH ON THE ISTHMUS OF PANAMA.

HON. JOHN BARRETT, American Minister to Panama, discusses 'The Panama Canal and its Problems,' in the *Review of Reviews* for February. He points out what is well known to all who have made any study of the matter at all, viz., that 'the average white laborers of the United States can not possibly stand the tropical climate,' and favors the plan of securing Jamaica negroes to do the work on the canal. Up to the present time the governor-general of Jamaica has insisted on conditions, under which alone these Jamaicans can go, that have not commended themselves to our Secretary of War and to the chief engineer of the canal. It is stated that the Jamaicans themselves are anxious to secure work on the canal. Plans are also being discussed for bringing in Porto Ricans, Chinese and Japanese, and there is said to be a growing feeling on the isthmus that the Chinese may be the laborers upon whom the Canal Commission will have to depend. Unless we are mistaken, however, the Chinese laborers imported by the French engineers to work on the canal did not prove satisfactory.

Under the lead of Col. Gorgas, who made a brilliant record as health officer at Havana, splendid efforts are being made to kill the mosquito-carriers of yellow fever and malaria, but both sufficient money and an extended organization to prosecute the work are lacking. During the past six months there have been about fourteen cases of yellow fever.

NOTE.

A PAPER on the 'Geography of Manchuria,' in the *Journal of Geography*, for January, 1905, contains a brief discussion of climate. The author is Professor N. M. Fenneman, of the University of Wisconsin.

R. DEC. WARD.

SCIENTIFIC NOTES AND NEWS.

SIR MICHAEL FOSTER has decided to offer himself for reelection to the next parliament as member for the University of London. He seeks reelection as a representative of science and higher education; if reelected he will take his seat as a member of the liberal party. A committee, with Sir Thomas Barlow as chairman, has been formed to promote his election.

THE Prussian Academy of Science has awarded its Helmholtz medal to Professor Ramón y Cajal, professor of neurology at Madrid.

THE Munich Academy of Sciences has awarded the Liebig medal for researches in agricultural chemistry to Dr. Adolf Frank, of Charlottenburg.

THE Royal Astronomical Society has awarded its Jackson-Gwilt bronze medal to Mr. Tebbutt, who for many years has carried on alone astronomical research in an observatory at his home in New South Wales.

M. JANSSEN, director of the observatory at Meudon, and M. Moissan, professor of chemistry at the Sorbonne, have been elected members of the St. Petersburg Academy of Sciences.

PROFESSOR SVANTE A. ARRHENIUS, of Stockholm, Professor W. F. P. Pfeffer, of Leipzig, and Professor W. Spring, of the University of Liège, have been elected honorary members of the German Chemical Society.

THE Physical Society of Frankfort has elected Professor E. Bamberger, of Zurich, and Professor J. Brühl, of Heidelberg, to honorary membership.

M. VIGER has been elected president of the French Society of Horticulture.

M. RADAU has been appointed president of the French Bureau of Longitude.

The Journal of the American Medical Association calls attention to the fact that the new French Cabinet contains two physicians, Dr. A. E. Gauthier, who is at the head of the department of public works which includes railroads, etc., and Dr. J. Dubief, minister of commerce. The latter was chief of the Marseilles Insane Asylum, 1886–1893, and then of the Rhone Asylum until elected deputy a year or so later. He has been a member of the committee on labor since 1902. The under-secretary of finance is also a physician, Dr. Merlou, who has served as deputy since 1889.

Dr. George Bitter, docent in botany at Münster, has been appointed director of the Botanical Garden at Bremen.

Dr. H. Ludwig, of Bonn, has declined a call to the directorship of the zoological museum of the University of Berlin.

Dr. Michele Cantone, professor of physics in the University of Pavia, has been appointed director of the Physical Institute at Naples.

Dr. Robert Stein has been transferred from the U. S. Geological Survey to the Bureau of Statistics, Department of Commerce and Labor.

Mr. Albert F. Woods, chief pathologist and physiologist of the Bureau of Plant Industry, United States Department of Agriculture, has been designated delegate on the part of the United States to the Second International Botanical Congress to be held at Vienna, June next. This action was taken by the secretary of agriculture through the secretary of state in response to a request from the government of Austria-Hungary to the government of the United States for official representation.

The Carnegie Institution has continued for two years in the future its annual grant for the payment of salaries to computers on the 'New Reduction of Piazzi's Star Observations.' But the work is much retarded by the lack of competent computers and suitable environment for their maintenance.

Professor Amadeus W. Grabau, of Columbia University, has received an extensive collection of fossils from the limestone region of Michigan, including many new types. He is to prepare a monograph on them for the State of Michigan.

Mr. Walter Maunder, who has conducted the astronomical department of *Knowledge* since the death of Mr. A. C. Ranyard in 1894, has resigned his connection with that journal.

It is proposed to erect a monument at Laibach, in Austria, to the memory of Vega, author of the well-known table of logarithms.

The Paris Mint has struck a medal in honor of Dr. B. Teissier, who died at the age of 23 from the consequences of an official medical mission to Egypt.

Professor Albert B. Prescott, professor of organic and applied chemistry, dean of the school of pharmacy and director of the chemical laboratory of the University of Michigan, died on February 26 in his seventy-third year.

We regret also to record the death of Dr. Hermann Landois, professor of zoology at Münster, at the age of seventy years; of Dr. Paul Uhlich, professor of geodesy of the Academy of Mines at Freiberg, at the age of forty-five years; and of Guido Hauck, professor of geometry in the Technical Institute of Berlin.

The next meeting of the Central Branch of the American Society of Naturalists and affiliated societies, the Central Branch of the American Society of Zoologists and the Botanists of the Central States, will be held at the University of Chicago on Friday and Saturday, March 31 and April 1, 1905. Titles of papers should be sent, together with abstracts of the same, to F. R. Lillie, secretary of Zoologists, or to H. C. Cowles, secretary of Botanists. A more extended notice of the program will be published in Science shortly before the meeting.

The general meeting of the American Philosophical Society will be held at Philadelphia on April 12, 13 and 14. Members intending to present papers are requested to send the titles to the secretaries without delay, so that they may be inserted in the preliminary program, which will be issued about March 10.

The January meeting of the Physico-Chemical Club of Boston and Cambridge was held at the Harvard Union, and papers were read by Professor T. W. Richards, Dr. H. A. Torrey and Dr. G. P. Baxter, all of Harvard. The subjects were respectively, 'The Atomic Weights of Sodium, Strontium and Chlorine,' 'The Dissociation of Phenoquinone and Quinhydrone' and 'The Oxidation of Oxalic Acid by Permanganate in the Presence of Hydrochloric Acid.'

The annual general meeting of the Neurological Society of Great Britain was held on February 16, when the presidential address was delivered by Sir John Batty Tuke. The subject of the address was the relation of the lunacy laws to the treatment of insanity.

THE proceedings of the American Forest Congress, held at Washington, D. C., January 2–6, under the auspices of the American Forestry Association, will be issued in book form on March 15. The volume will contain about 400 pages, and will be bound in cloth. It will contain the complete addresses by President Roosevelt, Secretary Wilson and fifty other speakers who were on the program, including not only those prominent in state and national forest work, but the leaders in the railroad, lumbering, mining, grazing and irrigation industries. It will be published for the American Forestry Association by the H. M. Suter Publishing Company, Washington, D. C.

THE seventh Australasian Medical Congress will be held in Adelaide, South Australia, from September 4 to 9, 1905, under the presidency of Dr. E. C. Stirling.

THE Massachusetts Zoological Society acknowledges gifts amounting to $12,900 towards the establishment of a zoological garden.

A TELEGRAM has been received at the office of the Scottish National Antarctic Expedition in Edinburgh announcing the safe arrival at Buenos Ayres of Mr. R. C. Mossman, who was left in charge of the meteorological station at Scotia Bay, South Orkneys, last February. Mr. Mossman has spent two continuous years in the Antarctic regions.

THE Adams prize for 1904 has not been awarded by Cambridge University. The subject for the prize for 1906, which is open to the competition of all persons who have at any time been admitted to a degree in the university, is 'The inequalities in the moon's motion due to the direct action of the planets.' The essays must be sent to the vice-chancellor on or before December 16, 1906. The value of the prize is about £225.

THE British Ornithologists' Club has started an inquiry into the migration of birds. Information will be gathered from the keepers of lighthouses and lightships on the southern and eastern coasts of England, and information from observers in each county of England and Wales.

THE New York State Commissioner of Agricluture Weiting has submitted to the senate a report on the operation of the pure food law. With the appropriation of $10,000, voted in 1904, the department has examined 780 samples of food and discovered 134 violations of the statute, sixty-four of which have been referred to the attorney general for prosecution.

THROUGH the courtesy of the Hydrographic Office of the Navy Department, and more particularly of Captain H. M. Hodges, hydrographer, and Mr. George W. Littlehales, the *National Geographic Magazine,* of Washington, D. C., publishes as a supplement to the February number a chart of the world on Mercator's projection, showing the submarine cable lines and their connections and ocean routes. Cable and telegraph lines are printed in red and ocean routes in blue. The latest cable lines are shown—as, for instance, the Alaskan cables of the U. S. Signal Corps and the wireless connection across Norton Sound. The tables of distances printed on the bottom of the chart will be found convenient. One table tells at a glance the comparative distances of New York and Shanghai, or Yokohama by the Panama, Suez and Cape of Good Hope routes. Another table gives the distances of our Gulf ports from the Atlantic end of the Panama Canal (Colon), and also from each other. The chart can be detached from the magazine and hung on the wall for more convenient use.

The British Medical Journal states that Professors Czerny, Erb, Hegar, Baumler and other distinguished representatives of medical science have lately with sanction of the government of the Grand Duchy of Baden, formed a committee at Karlsruhe with the object of discovering means of effectively combating the increase of cancer. On the proposal of Professor Czerny, who is the chairman of the committee, it has been decided to issue a circular to medical practitioners for the purpose of collecting complete statistics as to cancer cases occurring within the duchy. The cases will then be fully investigated. Special attention will be given to the question of the possible connection of cancer with local causes, its regional distribution, and the relative frequency of its occurrence among persons of various occupations. On the basis of informa-

tion thus obtained it is hoped that it may be possible to devise measures which may check the spread of the disease.

The report of progress of stream measurements for the calendar year 1903 has been published by the U. S. Geological Survey in four parts, all of which are now available. During 1903 the number of regular stations for stream measurements was steadily increased, so that at the close of the year systematic measurements were being taken at 521 stations. These are so distributed as to cover the needs of the various states and territories. New York stands at the head of the list, with 70 stations, Colorado comes next with 34, California follows with 32, Michigan has 25, Montana 20, Georgia 18, Texas and Wyoming each 17, Washington 16, Kansas 15, and all the other states less. Oklahoma has only 2 stations, the least number in any state or territory, and Indiana, Mississippi and New Hampshire claim only 3 apiece. This expansion of the work is the result of the constantly increasing demand from the general and the engineering public for the stream data collected by the survey.

UNIVERSITY AND EDUCATIONAL NEWS.

It is said that the late James C. Carter, the eminent New York lawyer, has bequeathed $200,000 to Harvard University.

It is reported that Mr. Andrew Carnegie has offered to give $500,000 to the University of Virginia on the condition that the authorities of the institution raise a similar amount from other sources.

The Board of Trustees of Princeton University has appointed a committee of fifty to raise an endowment fund of $2,500,000. The purpose is to establish a tutorial system which President Woodrow Wilson has advocated for some time past. Mr. Cleveland H. Dodge, '79, of New York, is chairman of the committee.

Comptroller Grout has announced that a bill will be introduced at Albany incorporating a University of Brooklyn. It is proposed to give the university land owned by the city and to make an appropriation for building and equipment. The plan is to unite in the university the Brooklyn Institute, the Public Library, the Polytechnic Institute, Adelphi College, the Packer Institute and the Long Island Medical College.

Plans are being drawn for the erection of five new buildings for the School of Education, the University High School and the Chicago Manual Training School at the University of Chicago. The buildings will contain a workshop, an assembly hall, a museum, gymnasium and a hall for recitation purposes. Ground has been reserved for them in the School of Education group. It is expected that the total cost will reach $1,000,000.

At the first of the winter convocations of the George Washington University on Washington's Birthday, a gift of property, estimated to be worth $100,000, was announced for the establishment of a chair and course of graduate study on the history of civilization. The name of the donor is withheld for the present. Various sums of money raised by the trustees and alumni association, aggregating $275,000, were also announced.

The Mercers Company has voted a sum of £1,000 for the promotion of the study of physiology at University College, London.

A Blue-book has been issued containing reports from the fourteen colleges which participated during the year ended March 31, 1904, in the annual grant, amounting to £27,000, made by the British Parliament for 'University Colleges in Great Britain,' and from the three colleges in Wales, which receive a grant of £4,000 each.

The senate of Durham University has decided that German may be offered as an alternative subject for Greek in the preliminary examination for the degrees of doctor in medicine and master in surgery.

Dr. Brachet, of Liège, has been appointed professor of anatomy in the University of Brussels.

Professor N. J. Andrusson, of the University of Dorpat, has been appointed professor of paleontology and geology at the University of Kiew.

Dr. R. Credner, of Greifswald, has been called to Breslau as professor of geography.